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MEMORANDUM

SUBJECT: Oxadiazon: Draft Ecological Risk Assessment for Registration Review

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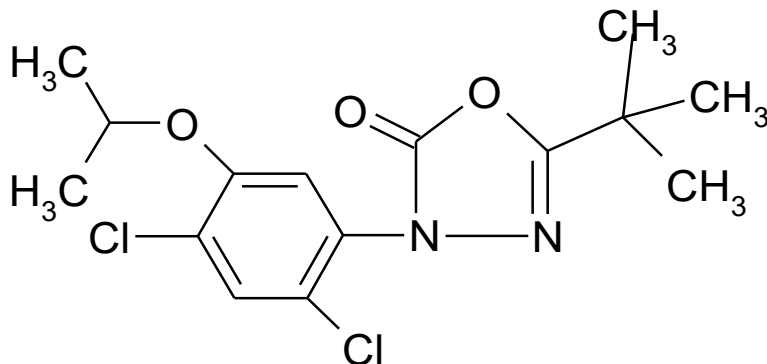
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The Environmental Fate and Effects Division (EFED) has completed the draft environmental fate and ecological risk assessment in support of the Registration Review of the herbicide oxadiazon.

Draft Ecological Risk Assessment for the Registration Review of Oxadiazon



Oxadiazon; CAS No: 19666-30-9

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1 Executive Summary

1.1 Overview

The Environmental Fate and Effects Division (EFED) has completed the Draft Ecological Risk Assessment for the registration review of oxadiazon (CAS No: 19666-30-9; PC code 109001). Oxadiazon is a light-dependent peroxidizing herbicide (LDPH) in the oxadiazolone chemical class and is registered for use on turf (non-residential), ornamentals, and rights-of-way areas.

Oxadiazon products are formulated as granules, flowable concentrates, pressurized liquids, soluble concentrates, and wettable powder in water soluble packets. Liquid and wettable powder formulations are applied as ground foliar spray while granular formulations are applied ground broadcast as dry granules.

1.2 Risk Conclusions Summary

Risks of concern for this herbicide involve effects to aquatic species on a chronic basis, based on reductions in survival, reproduction and body length. Specifically, RQ¹s for freshwater fish and estuarine/marine fish exceed the chronic LOC² of 1.0 for all scenarios modeled to represent oxadiazon use on turf and ornamentals. Chronic RQs are also above the LOC for freshwater and estuarine/marine invertebrates for some scenarios modeled to represent turf and ornamentals. For benthic invertebrates, chronic RQs were above the LOC for both turf and ornamentals. As anticipated for an herbicide, risk is expected to both vascular and non-vascular plants for use of turf and ornamentals.

Risks of concern are also identified for terrestrial species; risks were identified showing chronic effects to adult and larval honeybees. Chronic dose and dietary RQs are above the LOC for birds (where applicable as chronic dose-based risk for birds not estimated); these exceedances extend across most feeding strategies with the exception of birds feeding on seeds. It is noted, that there were no effects observed in the available chronic 2-generation mammalian reproduction study up to and including the highest concentration tested; however, there is uncertainty as there is a significant gap in this highest tested level and the concentrations that are predicted in food items as a result of the application of oxadiazon, which is registered for use of up to 4 lbs a.i.A as a single application (8 lbs a.i.A, annually).

Due to bioaccumulation, there is also a concern for piscivorous birds and mammals; dose and dietary based chronic RQs are highest for mammals consuming contaminated fish. For terrestrial invertebrates, ornamentals are assumed to be attractive to honeybees; chronic adult

¹ RQ refers to Risk Quotient

² LOC refers to Level of Concern

oral RQs are above the LOC. As anticipated for a herbicide, risk is also expected for terrestrial plants.

1.3 Environmental Fate and Exposure Summary

The environmental fate and transport suite of data for oxadiazon is considered complete. It is noted however, that an adjustment to account for the high unextracted residues was used for two of the three aerobic aquatic metabolism studies (Refer to **Appendix A**). Effect of this adjustment on exposure estimated environmental concentrations (EECs) is expected to be minimal. Additionally, stability was assumed for the anaerobic aquatic half-life of the chemical, in modeling, due to various uncertainties in the data. In the environment, the primary routes of surface water exposure are run-off (adsorbed to eroded soil) and drift from treated areas to adjacent surface water bodies. Except for rapid photolysis in shallow/clear aquatic systems, oxadiazon is expected to be highly persistent in soils and aquatic systems with the formation of minor degradation products.

1.4 Ecological Effects Summary

The ecological effects dataset for oxadiazon is largely complete. For aquatic taxa, oxadiazon is classified as moderately toxic to freshwater fish and invertebrates and estuarine/marine fish while being highly toxic to estuarine/marine invertebrates, all on an acute exposure basis. There were three chronic toxicity studies available for freshwater fish, with the most sensitive test showing significant reductions in survival relative to the control. An acute-to-chronic ratio was utilized to estimate the chronic toxicity to estuarine/marine fish. Chronic toxicity tests to freshwater and estuarine/marine invertebrates yielded the most sensitive endpoints of decreased reproduction and decreased growth, respectively. Additionally, sub-chronic (10-day) toxicity data are available for two species of freshwater sediment-dwelling invertebrates with significant reductions in mortality indicated for both species. There are no longer term (*i.e.* 28 to 60-day) studies investigating the potential effects to estuarine/marine benthic invertebrates available. Therefore, in the absence of chronic data and in accordance with the Agency guidance on benthic invertebrate risk assessment³, the chronic water column toxicity values from the available freshwater and estuarine/marine invertebrate studies will serve as a surrogate for estimating the potential chronic risk associated with oxadiazon to benthic invertebrates in the pore water.

Consistent with its mode of action, there were significant reductions to frond number and cell density, relative to the control, in the available vascular and non-vascular aquatic plant studies.

For terrestrial taxa, non-definitive endpoints were determined in acute oral studies to birds and mammals, as well as the sub-acute dietary studies for birds. In the most sensitive chronic avian

³ https://www.epa.gov/sites/production/files/2015-08/documents/toxtesting_ecoriskassessmentforbenthicinvertebrates.pdf

reproduction study, there was 25% mortality at the highest treatment level with no significant effects observed at the other two treatment groups. In a chronic 2-generation mammalian reproduction study, there were no significant effects observed up to and including the highest treatment group. Notably, the terrestrial food item EECs predicted for single oxadiazon application rates of 4.0 lbs a.i./A (max EEC of 1000 mg a.i./kg-bw or 1049 ppm, for dose and dietary-based exposure estimates, respectively) were one to two orders of magnitude higher than this highest treatment level where no effects were observed, and therefore there is uncertainty in the chronic risk estimation analysis for mammals.

Following the recommendation for the Tier I suite of honey bee data in the Problem Formulation, data were subsequently submitted for the acute and chronic oral toxicity to adult honey bees as well as the chronic toxicity to larval honey bees. Oxadiazon is classified as practically non-toxic to adult honey bees on an acute contact and oral basis. While there was no acute larval study available, there was no mortality above the 50% level observed during the exposure period of the chronic larval toxicity study. In that study, there were significant increases in mortality and decreases in percent emergence observed. Finally, in the chronic oral toxicity study to honey bee adults, there was significant effects on mortality observed. Notably, this study used a formulated product of oxadiazon while it is recommended that technical grade active ingredient is used.

As anticipated for a registered herbicide, there were significant effects on plant growth observed in the available terrestrial plant studies. For seedling emergence, monocot and dicots were similarly sensitive to the effects of oxadiazon, while dicots were approximately one order of magnitude more sensitive relative to monocots in the vegetative vigor study. In both studies, reductions in dry weight relative to the control were the most sensitive endpoints. There is one reported incident for the use of oxadiazon on golf course turf.

1.5 Identification of Data Needs

Environmental Fate

The environmental fate and transport data for oxadiazon lack submittal of the environmental chemistry methods (ECMs) and associated independent laboratory validations (ILVs) for soil and water. It is noted that an environmental chemistry method with self-validation was included as part of the TFD study (MRID 41767401) to determine oxadiazon and three of its metabolites the methoxy (RP17272), the phenolic (RP25496), and the carboxylic (RP26449) in soil only. The method sensitivity is approximately 0.01 ppm (10 ppb). This submittal does not satisfy current requirements for ECMs and associated ILVs for soil and water. These studies are requested as per OCSPP Guideline number 850.6100. Requested procedures should be more sensitive and state-of-the-art.

Ecological Effects

The ecological data set for oxadiazon is largely complete with the exception of the previous identified higher tier pollinator studies previously held in reserve. Given the Tier I risks above the LOC identified for individual adult and larval honey bees for pollinator attractive uses on ornamentals, higher tier data could refine the risks that were determined.

Table 1-1. Summary of Risk Quotients for Taxonomic Groups from Current Uses of Oxadiazon

Taxa	Exposure Duration	Risk Quotient (RQ) Range ²	RQ Exceeding the LOC for Non-listed Species	Additional Information/ Lines of Evidence
Freshwater fish	Acute	<0.01 – 0.09	No	--
	Chronic	3.0 – 86	Yes	Based on 9.8% reduction in survival at the LOAEC, all scenarios for all uses exceed the chronic LOC. RQs for granule formulations lower relative to flowable formulations, but still exceed LOC.
Estuarine/ marine fish	Acute	<0.01 – 0.04	No	--
	Chronic	2.0 - 69	Yes	Endpoint calculated using an ACR based on freshwater fish data. All scenarios for all uses exceed the chronic LOC. RQs for granule formulations lower relative to flowable, but still exceed LOC.
Freshwater invertebrates	Acute	<0.01 - 0.04	No	--
	Chronic	0.30 – 2.8	Yes	Based on 4.7% decrease in reproduction at LOAEC. RQs exceeded LOC for one scenario for ornamentals. Granule RQs for same scenario marginally (RQ = 1.3) exceeds LOC.
Estuarine/ marine invertebrates	Acute	0.10 - 0.39	No	--
	Chronic	0.07 - 1.6	Yes	Based on 4.5% decrease in body length, no reproductive endpoints assessed. RQs exceed LOC for one scenario for ornamentals. Granule RQ for same scenario marginally exceeds LOC.
Benthic invertebrates	Acute ¹	0.01 - 0.27 (E/M)	No	RQs not estimated for freshwater species due to non-definitive endpoints; EECs lower than highest test concentration with no effects observed. RQs do not exceed LOC for estuarine/marine species.
	Sub-chronic	<0.01- 0.06 (FW Sediment) 0.05 - 1.7 (E/M PW)	Yes (estuarine/marine species)	No sediment RQs exceed LOC for freshwater species; estuarine/marine sediment data unavailable. RQs with pore water EECs to chronic water column estuarine/marine invertebrate endpoint exceed the LOC for one scenario each for ornamental and rights-of-way uses. Granule RQs are lower than foliar RQS but still marginally exceed the LOC.
Mammals	Acute	Not calculated	--	RQs not calculated due to non-definitive endpoints; EECs lower than highest test concentration with no effects observed.

Taxa	Exposure Duration	Risk Quotient (RQ) Range ²	RQ Exceeding the LOC for Non-listed Species	Additional Information/ Lines of Evidence
	Chronic	Not calculated	--	No effects observed in chronic study but only tested up to 15.5 mg/kg-bw/day. Maximum dose (1000 mg a.i./ kg-bw) and dietary-based (1049 mg a.i./kg-diet) both exceed dose/concentration where no effects were observed. (15.5 mg a.i./kg-bw and 200 mg a.i./kg-diet) by 1-2 orders of magnitude. Therefore, all RQ were not estimated, there is high uncertainty on the potential for chronic risk to mammals given the gap of understanding potential effects between the highest potential exposure and highest level where no effects were observed.
Birds	Acute	Not calculated	--	RQs not calculated due to non-definitive endpoints; EECs lower than highest test concentration with no effects observed.
	Chronic	0.13 - 2.1	Yes	Based on 25% mortality at the highest treatment level.
Terrestrial invertebrates	Acute Adult	Not calculated	--	Acute contact and oral studies to adults had non-definitive endpoints; EECs lower than highest test concentration with no effects observed.
	Chronic Adult	3.0	Yes	Based on 62% mortality at highest treatment group.
	Acute Larval	No data	NC	50% mortality not observed during exposure phase on chronic larval study
	Chronic Larval	10	Yes	Based on 22% increase in mortality and 24% decrease in emergence
Aquatic plants	N/A	0.72 - 2.7 (vascular) 5.7 - 21 (non-vascular)	Yes	RQs based on decreased frond number (vascular) and decreased cell density (non-vascular). RQs exceed for all scenarios and uses. Granule RQs lower relative to flowable formulations but still all exceed LOC.
Terrestrial plants	N/A	1.1 - 16 (ground); <0.1 - 15 (granule)	Yes	LOC exceedances inclusive of monocots and dicots and all registered use patterns. Effects based on reductions in height and weight. Estimated 75% of usage of oxadiazon is as a granule formulation, which yield RQs above the LOC. One reported incident from use on golf course turf.

NC = Not calculated; FW = freshwater; E/M = estuarine/marine;

Level of Concern (LOC) Definitions:

Terrestrial Animals: Acute=0.5; Chronic=1.0; Terrestrial invertebrates=0.4

Aquatic Animals: Acute=0.5; Chronic=1.0

Plants: 1.0

¹ Based on water-column toxicity data compared to pore-water concentration.

² RQs reflect exposure estimates for parent oxadiazon and maximum application rates allowed on labels.

2 Introduction

This Draft Risk Assessment (DRA) examines the potential ecological risks associated with labeled uses of oxadiazon on non-listed non-target organisms. Federally listed threatened/endangered species (“listed”) are not evaluated in this document. The DRA uses the best available scientific information on the use, environmental fate and transport, and ecological effects of oxadiazon. The general risk assessment methodology is described in the *Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs* (“Overview Document”) (USEPA, 2004). Additionally, the process is consistent with other guidance produced by the Environmental Fate and Effects Division (EFED) as appropriate. When necessary, risks identified through standard risk assessment methods are further refined using available models and data. This risk assessment incorporates the available exposure and effects data and most current modeling and methodologies.

3 Problem Formulation Update

The purpose of problem formulation is to provide the foundation for the environmental fate and ecological risk assessment being conducted for the labeled uses of oxadiazon. The problem formulation identifies the objectives for the risk assessment and provides a plan for analyzing the data and characterizing the risk. As part of the Registration Review (RR) process, a detailed Problem Formulation⁴ for this DRA was published to the docket in January 2015. The following sections summarize the key points of the problem formulation and discusses key differences between the analysis outlined there and the analysis conducted in this DRA.

As summarized in the Problem Formulation based on previous risk assessments, potential risks associated with the use of oxadiazon include risks to aquatic invertebrates, aquatic plants, terrestrial plants, fish, and mammals.

Since the problem formulation was completed, the following environmental fate data have been submitted:

- Aerobic metabolism study in marine aquatic system (MRID 494052-01)
- Aerobic soil metabolism study (MRID 501307-01)

More specific information on these new data is described in **Section 5** and **Section 8.1**. The additional data resulted in updated aquatic modeling input values.

Since the preliminary problem formulation was completed, the following ecotoxicity data have been reviewed and incorporated into the suite of data to support oxadiazon:

- Chronic early life stage toxicity study with freshwater fish (OCSP 850.1400) under enhanced light conditions (MRID 48759101);

⁴ EFED Registration Review Problem Formulation for Oxadiazon. DP Barcode D420615 dated December 5, 2014.

- Honey bee adult acute contact toxicity test (OCSP 850.3020) (MRID 49984304);
- Honey bee adult acute oral toxicity test (Non-guideline, OECD TG 213) (MRID 49984304);
- Honey bee larval chronic toxicity test (Non-guideline, OECD TG 245) (MRID 50580801);
- Honey bee adult chronic toxicity test (Non-guideline, OECD Draft Guidance) (MRID 50580802)
- Seedling emergence study (OCSP 850.4100) (MRID 46676502);
- Vegetative vigor study (OCSP 850.4150) for (MRID 46676503).
- Chronic mysid life cycle study (OCSP 850.1350) (MRID 46473304)
- 10-Day (subchronic) sediment toxicity study with freshwater species (OCSP 850.1735, *Chironomus tentans*, MRID 46473303)
- 10-Day (subchronic) sediment toxicity study with freshwater species (OCSP 850.1735, *Hyaella azteca*, MRID 46487301)

3.1 Mode of Action for Target Pests

Oxadiazon (3-[2, 4-Dichloro-5-(1-methylethoxy) phenyl]-5-(1, 1-dimethyl-ethyl)-1, 3, 4-oxadiazol-2(3H)-one) is a light-dependent peroxidizing herbicide (LDPH) in the oxadiazolone chemical class. The Herbicide Resistance Action Committee (HRAC) classify the oxadiazole family under Group E while it is under Group 14 in the Weed Science Society of America (WSSA) classification scheme.⁵ Oxadiazon is used for pre- and early post-emergence control of grassy and broadleaf weeds in turf, golf courses, sod farms, conifer and ornamental plantations, rights-of-way, and residential and commercial sites such as ornamental landscapes, parks, athletic fields and cemeteries. There are currently no food uses registered. LDPH chemicals target a specific enzyme, protoporphyrinogen oxidase, in the heme and chlorophyll biosynthetic pathway. Inhibiting protoporphyrinogen oxidase in plants leads to an accumulation of phototoxic heme and chlorophyll precursors that, in the presence of light, produce activated oxygen species which rapidly disrupt cell membrane integrity. Oxadiazon is a contact herbicide affecting the young weed shoot as it grows through the treated zone. Symptoms of injury generally consist of areas of necrotic tissues at the area of contact with the herbicide. Furthermore, residual effects of oxadiazon on grass cover crops have been observed for five months after treatment compared to 60 days in container nurseries⁶.

⁵ Herbicide Resistance Action Committee (HRAC) URL: <https://hracglobal.com/tools/classification-lookup?sort=wssa&s=Oxadiazole>

⁶ NC State Extension Publication URL: <https://content.ces.ncsu.edu/ronstar-oxadiazon>

3.2 Label and Use Characterization

3.2.1 Label Summary

Oxadiazon is a selective herbicide used to control annual grasses and broadleaf weeds in turfgrass and ornamentals including landscape ornamental beds on residential properties by a professional applicator. Use sites are limited to terrestrial nonfood, residential, commercial, and nursery use sites.

The Biological and Economic Assessment Division (BEAD) prepared a Pesticide Label Use Summary (PLUS) Report summarizing all registered uses of oxadiazon based on actively registered labels in October 2019. The PLUS report was used as the source to summarize representative uses for this DRA. Additionally, some of the labels were reviewed to clarify the nature of the use patterns, application procedures and timing. **Table 3-1** summarizes information from the PLUS report and selected labels.

Table 3-1. Summary of the Maximum Labeled Use Patterns for Oxadiazon (ground application only)

Use Site		Application Parameters ¹	Application Timing and Other Notes
Turf	Golf Courses: Fairways	4 x 2= 8 @ 120 d Applied broadcast or broadcast directed to soil or tolerant foliage	To be applied prior to weed seed germination. Due to variability in the time of weed seed germination for various types of weeds, application timing could be Late winter or early spring (up to end of April), Late summer to early fall, early spring prior to turf green-up, or in the fall after turf has become dormant (<i>i.e.</i> , throughout the year, except winter months, depending on types of weeds to be controlled).
	Others, Except Residential ²		
Ornamentals	In Nurseries ³		Timing is related to weed type and pressure noting that the herbicide is a weed pre-emergence herbicide. Therefore, it is to be applied early as the herbicide is most effective in controlling young weed seedlings during germination. To be applied to established ornamentals prior to bud break or not until 4 weeks after bud break.
	Residential Ground Cover Areas ⁴		
Right-of-Way			

¹ **Application Parameters:** 4 x 2= 8 @ 120 d means: maximum single rate= 4 lbs. a.i./A applied at a maximum of two times per year for a maximum yearly rate of 8 lbs. a.i./A/Year at 120-day interval

² **Others Except Residential:** outdoor turf grass present in occupational, manufacturing, processing, industrial, recreational, parks, institutional, and retail areas. Turf grass in residential areas is not included

³ **Ornamentals in nurseries** including containerized or non-containerized woody **ornamental shrubs, vines, trees and conifer nurseries (4-weeks seedlings)**

⁴ **Residential ground cover areas:** landscaped areas of solid or mixed stands of trees, shrubs, and ground covers located along public and private roadsides and rights-of-way, around commercial properties, recreational parks, railroad rights-of-way, railroad yards, and on federal, state, and local parks and recreational areas as well as open areas of the residential properties

Restrictions that were on all labels and apply to all use patterns include:

- A definition of ornamentals in residential properties uses as landscape beds consisting of well-defined areas of solid or mixed stands of trees, shrubs, and ground covers located around the outside of buildings and other structures as well as open

areas of the residential property. Residential turf is not included in the definition (no registered uses on residential turf);

- Only professional applicators are permitted to perform applications to ornamentals in residential properties (not for sale/use by homeowners);
- Application to golf courses is restricted to fairways (no application to putting greens or tees);
- Outdoor terrestrial non-food/nonfeed use only; and
- Not to use on exposed material as food or feed for livestock

Other label recommendations included:

- In the case of applications to landscape ornamentals, it is recommended to remove existing weeds before application and if rain is not expected shortly after application, thorough overhead irrigation immediately after “over the top sprays” is required to move the herbicide from the foliage to the soil surface. In the case of granular application to turf, it is recommended to rake leaves from the surface and to mow the grass before application and if rain is not expected shortly after application to irrigate immediately after application. This is because oxadiazon controls weeds by killing the young weed seedlings as they come in contact with the herbicide during germination (a pre-emergence herbicide);
- Application by ground equipment only; and
- The amount of oxadiazon that may be applied across products is limited to 8 lbs. of oxadiazon per acre/ year in areas of heavy weed infestation. A lower rate of 6 lbs. of oxadiazon per acre/ year is recommended for lower weed infestation.

Finally, there are 55 oxadiazon products. The products are formulated as granules (49 products containing 0.63 to 2.00% a.i “active ingredient”), and flowable concentrate (2 products containing 34.1 and 50%). Additionally, one product formulation of each of the following: pressurized liquid (1% a.i), soluble concentrate (34.4% a.i), and wettable powder (50%) in water soluble packets. Liquid and wettable powder formulations are applied as foliar spray while granular formulations are applied broadcast as dry granules.

3.2.2 Usage Summary

Based on BEAD market usage data for 2013, national usage of oxadiazon was 321,375 lbs. a.i that year with no data on acreage treated for any other year. Data indicates that usage was nationally limited to turf (golf courses, sod and other) followed by landscape ornamentals, ground cover and ornamentals grown in nurseries (**Figure 3-1**). In contrast, California usage data for oxadiazon averaged 1,078 lbs. a.i. (<1% of the national usage) for the years from 2012 to 2016 and was reduced, in 2017, to 635 lbs. a.i. (**Figure 3-1**). It is noted that California usage in 2016 indicated that 75% of the pesticide was used on landscape maintenance, 14% in nurseries and 9% on right of way and 2% on turf. Additionally, granular formulations represented most of the usage (75%) followed by water soluble bags of wettable powder (25% of usage).

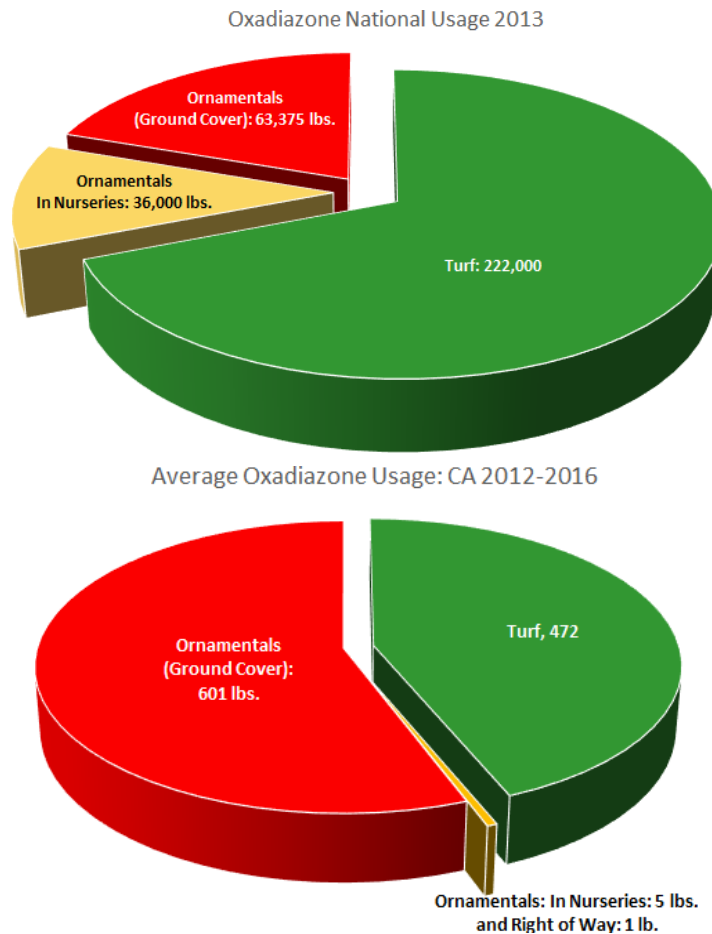


Figure 3-1. National and California Level Oxadiazon Usage Data

4 Residues of Concern

In this risk assessment, the stressors are those chemicals that may exert adverse effects on non-target organisms. Collectively, the stressors of concern are known as the Residues of Concern (ROC). The residues of concern usually include the active ingredient, or parent chemical, and may include one or more degradates that are observed in laboratory or field environmental fate studies. Degradates may be included in, or excluded from, the ROC based on submitted toxicity data, percent formation relative to the application rate of the parent compound, modeled exposure, and structure-activity relationships (SARs). Structure-activity analysis may be qualitative, based on retention of functional groups in the degradate, or they may be quantitative, using programs such as ECOSAR, the OECD Toolbox, ASTER, or others.

There are no ecotoxicity data available for the degradation products of oxadiazon. Based on the guidance for the residues of concern in ecological risk assessment⁷, parent oxadiazon is the residue of concern for this aquatic/terrestrial assessment. This decision is based on the following considerations:

1. Parent oxadiazon is expected to be highly persistent with no major degradate; and
2. The observed minor degradates (refer to **Section 5**: the environmental fate summary) were in the maximum range of 0.1 to 5% and their sum is not expected to substantially change exposure estimates when modeled with the Total Residue (TR) method. It is noted that minor degradates of oxadiazon are a result of minor structural change and therefore, their toxicity may be considered like its parent.
3. Using ECOSAR for parent oxadiazon resulted in a poor predictor (*i.e.* greater than 1 order of magnitude difference) in the empirical data relative to estimates. Therefore, the additional ECOSAR classes of other minor degradates were not further explored.

5 Environmental Fate Summary

Table 5-1 summarizes the physical chemical properties of oxadiazon.

Table 5-1. Summary of Physical-Chemical, Sorption, and Bioconcentration Properties of Oxadiazon.

Parameter	Value ¹			Source MRID/Study Classification/Comment
Molecular Weight (g mole ⁻¹)	345.20			Chemical profile
Molecular Formula	C ₁₅ H ₁₈ Cl ₂ N ₂ O ₃			
Water Solubility at 20 °C ppm	0.70			41474201
Vapor Pressure (torr)	7.76 x 10 ⁻⁷ , 25 °C			41230301 semi volatile from dry soils
Henry's Law constant at 20 °C	5.03 x 10 ⁻⁷ atm m ³ mole ⁻¹			Estimated from vapor pressure and water solubility. Limited volatility from water or moist soils.
Octanol-water partition coefficient (K _{ow}) at 25°C (unitless)	81,283 (log K _{ow} =4.91)			41230302 Based K _{ow} alone: Likely to bioconcentrate significantly
Log Octanol-air partition coefficient (K _{0A})	10.3			EPIWEB 4.1 estimate (K _{0A} WIN)
Air-water partition coefficient (K _{ow})	3.0x10 ⁻⁶ (log K _{AW} = -5.527); (unitless)			EPIWEB 4.1 estimate; semi volatile from water
Soil-Water Distribution Coefficients (Kd in L/kg-soil) Organic carbon normalized distribution coefficients (Koc in L kg ⁻¹ organic carbon)	Soil/Sediment	Kd	Koc	41898202 (A); Slightly mobile (FAO classification system); Koc is a better predictor of sorption based on lower Coefficient of Variation (CV)
	Silt loam, pH 7.1	16.91	1,409	
	Clay, pH 6.7	22.83	1,903	
	Sandy loam, pH 6.5	11.39	2,848	
	Sand, pH 7.4	8.17	3,268	
	Mean	14.8	2,357	
	CV	71%	43%	
	Species	BCF	Depuration	42226701 (A); Moderate bioconcentration

⁷ Guidance for Residues of Concern in Ecological Risk Assessment, URL: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/guidance-residues-concern-ecological-risk-assessment>

Parameter	Value ¹			Source MRID/Study Classification/Comment
Steady State Bioconcentration Factor (BCF) L/kg-wet weight fish	Bluegill sunfish	1,111 Whole Fish	t½ ~ 3 days	potential

Data in **Table 5-1** indicate that oxadiazon is classified as slightly mobile based on measured K_{oc} values and the FAO classification system (FAO, 2000)⁸. Oxadiazon may be transported to surface water via spray drift and runoff (adsorbed to eroded soil) or to groundwater via slow leaching (due to its relatively high K_{oc}) at the long-term (years) due to its high persistence. Limited leaching observed in two terrestrial field dissipation studies supports a classification of slight mobility. In these studies, oxadiazon was detected only in the top 30 cm of the soils, with occasional small detections in the 15-30-cm layers. Oxadiazon is expected to be found in both water and sediment. Octanol-water partition coefficient (K_{ow}) and organic-carbon normalized soil-water distribution coefficient (K_{oc}) values trigger the need to conduct a separate sediment exposure assessment (40 CFR Part 158.630).⁹ Compounds with a log K_{ow} of three and above are generally considered to have the potential to bioconcentrate in aquatic organisms. Based on log K_{ow} of 4.9, bioconcentration of oxadiazon is suggested. However, results of the bioaccumulation test in bluegill sunfish indicated relatively low bioconcentration factors and rapid depuration.

Oxadiazon is classified as semi-volatile from water and dry non-adsorbing surfaces (USEPA, 2010a). The estimated log octanol-air partition coefficient (K_{OA}) value is 10.3, suggesting that oxadiazon is likely to accumulate in terrestrial organisms¹⁰. Based on oxadiazon physical-chemical and sorption characteristics, limited dissipation is expected due to volatilization from water and wet/dry soils and leaching to groundwater.

Table 5-2 summarizes representative degradation half-life values from laboratory degradation data for oxadiazon.

Table 5-2. Summary of Environmental Degradation Data for oxadiazon.

Study	System Details	Representative Half-life ^{1,2}	Source MRID/Classification
Abiotic Hydrolysis	pH 5, 7, 9	Stable (pH 5 & 7); 38 days (SFO-LN, pH 9)	41863603 (A)

⁸ Food and Agriculture Organization of the United Nations. FAO PESTICIDE DISPOSAL SERIES 8. Assessing Soil Contamination: A Reference Manual. Appendix 2. Parameters of pesticides that influence processes in the soil. Editorial Group, FAO Information Division: Rome, 2000. URL: <http://www.fao.org/DOCREP/003/X2570E/X2570E00.htm>

⁹ Sediment data may be required if the soil-water distribution coefficient (K_d) is ≥ 50 L/kg, K_{oc} s are ≥ 1000 L/kg-organic carbon, and the log K_{ow} is ≥ 3 (40 CFR Part 158.630). Sediment data may also be requested if there may be a toxicity concern.

¹⁰ A recent FIFRA Scientific Advisory Panel (SAP) reported, "Gobas *et al* (2003) concluded that chemicals with a log K_{OA} greater than five can bio-magnify in terrestrial food chains if log K_{ow} greater than two and the rate of chemical transformation is low. However, further proof is needed before accepting these limits without reservations" (SAP, 2009). This was also supported by the work of Armitage and Gobas (Armitage and Gobas, 2007).

Study	System Details	Representative Half-life ^{1,2}	Source MRID/Classification
Atmospheric Degradation	Hydroxyl Radical	10.5 Hours	EPIWEB 4.1 estimate
Aqueous Photolysis	pH 5, 25°C, 40 °N	2.8 days (SFO-LN)	41897201 (A)
Soil Photolysis	CA Sandy loam, 25°C, pH 7.5, 40 °N	165 days (SFO-LN)	41898201 (A)
Aerobic Soil (End of Study= EOS= 365 days)	UK Sandy loam, 25°C	866 days (SFO-LN)	42773801 (S)
	UK Clay loam, 20°C	1,246 days (SFO)/881 @25°C	50130701 ^N (S)
	UK Sandy loam, 20°C	1,055 days (SFO)/746 @25°C	
	UK Sandy loam, 20°C	756 days (SFO)/535 @25°C	
Aerobic Aquatic (1 st & 2 nd studies EOS= 97 d and 2 nd study EOS= 101 d)	UK Sandy Loam (Lake), 20°C	460 days (SFO)/325 @25°C	46594701 (S)
	UK Sandy clay loam, 20°C ³	617 days (SFO)/436 @25°C	49405201 ^N (S)
	Marine Sand, 20°C	241 days (SFO)/170 @25°C	
Anaerobic Aquatic ⁴ (366 d study; 25 °C)	CA sandy loam soil, 25°C	571 d or 893 d (SFO); to be Considered Stable in modeling	42773802 (S)

¹ **Half-lives:** SFO=single first order; **SFO-LN**=SFO calculated using natural log transformed data; DFOP=double first order in parallel; DFOP slow DT₅₀=slow rate half-life of the DFOP fit

² **Studies classification:** A= Acceptable, S= Supplemental; N/A= Not applicable noting that Studies submitted since the Problem Formulation was completed are designated with an ^N in association with the MRID number

³ **Aerobic Aquatic Half-lives** recalculated after omitting replicates containing more than 5% un-extracted residues (UER) from 7 to 28 day and by applying a correction for >42-day data to include the level of 8% UER (refer to Appendix A for more details concerning the high unextracted residues found in this study)

⁴ **Anaerobic Aquatic:** This study was performed on a soil rather than sediment. DER was modified by considering data for one of the replicates (180-day sample) as an outlier. For this replicate, a cluster of radioactivity (18% of the applied) was not characterized. Additionally, two half-lives were calculated one for all data while the other for data up to 269 days by considering data for the 366-day sample as an outlier, Half-life was recalculated using NAFTA PEST DF. In the problem formulation (PF) indicated that the chemical is to be considered stable in anaerobic aquatic systems

Based on laboratory fate data in **Table 5-2**, oxadiazon degraded very slowly by aerobic metabolism in soils and aquatic systems (half-lives “t_{1/2}” ranged from 756 to 1,246 days at 20°C in four soils and between 241 to 617 days in three water: sediment systems). Metabolism data in aerobic soil and aquatic systems indicate that oxadiazon is persistent based on the Goring persistence scale (Goring et al., 1975).¹¹ Oxadiazon is stable to hydrolysis at pH 5 and 7, and essentially stable to anaerobic aquatic metabolism. At pH 9, the chemical is slightly persistent (t_{1/2}= 38 days). Oxadiazon is likely to degrade via aqueous photolysis in shallow/clear water bodies and possibly on moist leaf surfaces (aqueous photolysis t_{1/2}= 2.75 days). There were no major transformation products observed from the environmental degradation of oxadiazon. However, the following minor transformation products were observed in amounts ranged from 0.1 to 5%:

- 3-(2,4-Dichloro-5-methoxyphenyl)-5-(1,1-dimethylethyl)-1,3,4-oxadiazol-2(3H)-one (RP 17272)

¹¹ Goring et al. (1975) provides the following persistence scale for aerobic soil metabolism half-lives:

- Non-persistent less than 15 days
- Slightly persistent for 15-45 days
- Moderately persistent for 45-180 days, and
- Persistent for greater than 180 days.

- 3-(2,4-Dichloro-5-hydroxyphenyl)-5-(1,1-dimethylethyl)-1,3,4-oxadiazol-2(3H)-one (**RP 25496**)
- 2- [2,4-Dichloro-5-(1-methyl ethoxy) phenyl] hydrazide 2,2-dimethylpropanoic acid (**RP 26123**)
- 4- [2,4-Dichloro-5-(1-methyl ethoxy) phenyl]-4,5-dihydro- α , α -dimethyl-5-oxo-1,3,4-oxadiazole-2-acetic acid (**RP 26449**)
- 4-(2,4-Dichloro-5-hydroxyphenyl)-4,5-dihydro- α , α -dimethyl-5-oxo-1,3,4-oxadiazole-2-acetic acid (**RP 26471**)
- Hydrazine carboxylic acid, l- [2,4-dichloro-5-(1-methyl ethoxy) phenyl]-2-(2,2-dimethyl-1-oxopropyl)-, methyl ester (**RP 32507**)
- 1,3,4-Oxadiazol-2(3H)-one, 3-(2-chloro-5-hydroxyphenyl)-5-(1,1 di-methyl ethyl) (**RPA 409407**)

Furthermore, oxadiazon mineralization to carbon dioxide was limited (maximum evolved 1 to 7%). **Appendix A** includes additional information on the environmental fate studies; a summary of structures and available information on the degradates of oxadiazon; and a summary of the maximum amounts of degradates formed in different aerobic soil systems.

With the exception of the aerobic aquatic metabolism study, unextracted residues were observed in amounts ranging from 3 to 15%. In the aerobic aquatic metabolism studies, unextracted residues ranged from 27 to 31% due to the low efficiency of the extraction systems used in this study. **Appendix A** contains details of the extraction systems used in various fate studies and the approach used to deal with the high amounts of unextracted residues in one of these studies.

A summary of terrestrial field dissipation data is provided in **Table 5-3**. The initial dissipation half-lives (DT_{50} s) in the available terrestrial field dissipation studies ranged from 65 to 40 days with an overall DT_{50} s ranging from 115 to 144 days at two sites; one in California and another in North Carolina. The low degradation rates of oxadiazon were reflected in the low concentrations observed for the tracked degradates. The concentrations of the tracked degradates (RP-17272 and RP-26449) ranged from 1.1 to 2%. Carryover of oxadiazon parent over more than a year was up to 5-6%. Overall, these results indicate that field dissipation (persistence and movement) of oxadiazon are highly dependent on the environmental conditions. For example, the dissipation rates in both sites were near zero during the wintertime.

Most residues in terrestrial field dissipation studies remained in the top 30 cm soil layer suggesting a low leaching potential to groundwater within the studies length (16-18 months). The range of half-lives in laboratory studies was much longer (535 to 881 days) than those observed in the field (115 to 144 days). This is because field dissipation studies are designed to capture a range of loss processes while laboratory studies are designed to capture loss from one process (*e.g.*, hydrolysis, aerobic metabolism, etc.). Thus, the values from laboratory studies are not directly comparable to the values from the field studies; however, it is

informative to have some understanding of how the laboratory data compares to the loss rates in the field dissipation studies.

Table 5-3. Summary of Field Dissipation Data for Oxadiazon

System Details	Application Information	Half-life (DT ₅₀) ¹	Max Leaching Depth	Source (Classification)
CA, Sandy loam soil (pH 8.0, 0.3 % O.C)	Granular product applied to juniper planted plots	115 days (SFO-LN)	30 cm	MRID 41767401 (Acceptable)
NC, Loamy sand soil (pH 7.1, 0.2% O.C)	Granular product applied to azaleas planted plots	144 days (SFO-LN)	30 cm	

¹ SFO-LN = single first-order calculated using natural log-transformed data

Oxadiazon is formulated as liquid or wettable powder when applied as liquid spray. Additionally, the chemical is formulated as granules and is applied as dry granules. The target of application is the soil to control newly germinated weeds. Therefore, labels recommend direct soil application or washing-off to soil via rainfall or irrigation. Recommended application procedures suggest that most of the chemical is intended to reach the soil system, although smaller particulates of the chemical mass are expected to be carried by drift from liquid foliar application into aquatic systems. Oxadiazon reaching the soil system is expected to dissipate by very slow degradation and leaching to shallow ground water. Run-off is expected to be a major process in oxadiazon dissipation, because it is expected to partition into the soil particles and be carried by run-off, with eroded soil, into aquatic systems. Oxadiazon reaching aquatic systems by drift and run-off is expected to dissipate slowly by degradation in aerobic/alkaline conditions by biotransformation/hydrolysis. Finally, volatilization is not expected to play a significant role in oxadiazon dissipation from the soil/aquatic systems.

6 Ecotoxicity Summary

Ecological effects data are used to estimate the toxicity of oxadiazon and its compounds to surrogate species. These ecotoxicity data have been reviewed previously and utilized in past ecological risk assessments (specifically the EFED Risk Assessment for the Reregistration Eligibility Decision of Oxadiazon, DP 277968, October 25, 2001) as well as in the Problem Formulation to support Registration Review (USEPA 2014; DP 420615). These data are summarized in **Section 6.1** and **Section 6.2**. Various studies with terrestrial and aquatic plants, birds (which serve as surrogates for reptiles and terrestrial-phase amphibians), aquatic animals (where freshwater fish serve as surrogates for aquatic-phase amphibians) and honey bees (which serve as surrogates for non-*Apis* bees exposed to either TGAI or formulated oxadiazon), were received since the Problem Formulation. The results of these studies are described briefly in this section as well as a summary of the existing suite of data.

Tables 6-1 and **6-2** summarize the most sensitive measured toxicity endpoints available across all aquatic and terrestrial taxa, respectively. These endpoints are not likely to capture the most sensitive toxicity endpoint for a particular taxon but capture the most sensitive endpoints across tested species for each taxon. All studies summarized in these tables are classified either

as acceptable or supplemental. Non-definitive endpoints are designated with a greater than or less than value. Endpoints that originate from newly submitted data (since the time of the Problem Formulation) are designated with an N footnote associated with the MRID number in the tables; endpoints that will be used in risk estimation have been bolded. A search of the ECOTOX open literature report for oxadiazon (September 2019) did not return any relevant ecotoxicity information that was more sensitive than currently available endpoints.

6.1 Aquatic Toxicity

Available data for freshwater and estuarine/marine fish indicate that oxadiazon is moderately toxic on an acute basis (LC₅₀ of 1.2 and 1.5 mg a.i./L, respectively). On a chronic basis, there are three early life stage studies available for freshwater fish. Chronic NOAEC values for standard lighting conditions range from 0.88 (rainbow trout) to 33 µg a.i./L (fathead minnow). Additionally, an enhanced light study is available for fathead minnow to evaluate the potential enhanced toxicity of oxadiazon under higher light conditions. While the enhanced light study yielded an endpoint one order of magnitude more sensitive than the standard light study for the same species of fish (fathead minnow), the standard light study for rainbow trout was the most sensitive endpoint based on a 9.8% reduction in survival at the LOAEC. It is unknown to what extent an enhanced light study with a rainbow trout would yield a potentially more sensitive endpoint relative to the enhanced light study.

There were no chronic data available for estuarine/marine fish, and therefore an acute-to-chronic ratio (ACR) using acute and chronic rainbow trout data and acute data for the sheepshead minnow was utilized. The ACR method estimated a chronic endpoint for estuarine/marine fish of 1.1 µg a.i./L to be used for chronic risk estimation.

For invertebrates, available acute data indicate oxadiazon is, at most, moderately toxic to freshwater invertebrates (>2.4 mg a.i./L) and highly toxic to estuarine/marine invertebrates (0.27 mg a.i./L). A chronic life cycle study for freshwater invertebrates yielded NOAEC of 30 µg a.i./L based on a 5% reduction in the number of offspring. A chronic life cycle study with estuarine/marine invertebrates yielded a NOAEC of 44 µg a.i./L, based on a reduction in male body weight at the highest treatment concentration.

Additionally, there are two 10-day sediment toxicity studies available to evaluate the subchronic toxicity of oxadiazon to two freshwater benthic species. In a 10-day freshwater midge study (*Chironomus tentans*), there were no significant effects observed, other than an increase in mortality (16%) at the highest treatment level (mean measured sediment value of 1,700 mg/kg sediment). There were no observed significant effects on dry weight. Similarly, in another study with the freshwater amphipod (*Hyalella azteca*), significant increases in mortality (45%) were observed at the highest treatment level only (mean measured concentration of 360 mg/kg sediment). Weight data were not collected in this study. There were no longer term (*i.e.* 28-60 day) studies available investigating reproductive parameters, nor were there studies available investigating the potential impacts to estuarine/marine sediment dwelling invertebrates. Therefore, in the absence of chronic data and in accordance with the Agency

guidance on benthic invertebrate risk assessment¹², the chronic water column toxicity values from the available freshwater and estuarine/marine studies will serve as a surrogate for estimating the potential chronic risk associated with oxadiazon to benthic invertebrates in the pore water.

Consistent with its use as an herbicide, there were significant effects to vascular and non-vascular aquatic plants for multiple species investigating impacts to cell density. In general, non-vascular plants were most sensitive relative to vascular aquatic plants.

Table 6-1. Summary of Aquatic Toxicity Endpoints for Oxadiazon

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value in µg a.i./L (unless otherwise specified) ¹	MRID or ECOTOX No./ Classification	Comments (see item 1 above)
Freshwater Fish (surrogates for vertebrates)					
Acute	Not reported	Rainbow trout (<i>Oncorhynchus mykiss</i>) and Bluebill sunfish (<i>Lepomis macrochirus</i>) (Scientific name)	96-h LC ₅₀ = 8.2 mg/L	00068525, 000068526 Supplemental	Purity not reported.
	TGAI (95.9)	Rainbow trout (<i>Oncorhynchus mykiss</i>)	96-h LC ₅₀ = 1.2 mg a.i./L	42360501 Acceptable	Moderately toxic
Chronic	TGAI 97.5	Rainbow trout (<i>Oncorhynchus mykiss</i>)	60-day NOAEC = 0.88 LOAEC = 1.7	41811601 Supplemental	↓ 9.8% in survival, individual replicate raw data not available for growth endpoints
	TGAI (98.5)	Fathead minnow (<i>pimephales promelas</i>)	32-day NOAEC = 33; LOAEC = 84	42921601 Acceptable	↓ 5 % in total weight; Highest two treatment concentrations (290 and 630 µg a.i./L excluded from further endpoint analysis due to decreased survival in these groups.
	TGAI (99.4)	Fathead minnow (<i>pimephales promelas</i>)	32-day (enhanced light conditions) NOAEC: 1.6; LOAEC: 3.8	48759101 Acceptable	↓ 14% in percent hatch; Highest two treatment concentrations (6.5 and 13 µg a.i./L excluded from further endpoint analysis due to decreased survival in these groups.
Estuarine/marine Fish (Surrogates for vertebrates)					

¹² https://www.epa.gov/sites/production/files/2015-08/documents/toxtesting_ecoriskassessmentforbenthicinvertebrates.pdf

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value in µg a.i./L (unless otherwise specified) ¹	MRID or ECOTOX No./ Classification	Comments (see item 1 above)
Acute	TGAI (95.9)	Sheepshead minnow (<i>Cyprinodon variegatus</i>)	96-h LC ₅₀ = 1.5 mg a.i./L	42615801 Acceptable	Moderately toxic
Chronic	No data available. Acute-to-chronic ratio (ACR) estimated from available acute and chronic data for freshwater and estuarine/marine fish.				
Freshwater Invertebrates					
Acute	TGAI (95.9)	Water flea (<i>Daphnia magna</i>)	48-h LC ₅₀ = >2.4 mg a.i./L	42331801 Acceptable	Moderately toxic
Chronic	TGAI (97.5)	Water flea (<i>Daphnia magna</i>)	21-day NOAEC = 30; LOAEC = 55	41784301 Acceptable	↓4.7% decrease in reproduction
Estuarine/ marine invertebrates					
Acute	TGAI (95.9)	Mysid shrimp (<i>Mysidopsis bahia</i>)	96-h LC ₅₀ = 0.27 mg a.i./L	42615802 Acceptable	Highly toxic
Acute	TGAI (95.9)	Eastern oyster (<i>Crassostrea virginica</i>)	96-h LC ₅₀ = 0.70 mg a.i./L	42570301 Supplemental	Highly toxic; average control shell deposition lower than guideline recommendations
Chronic	TGAI (97)	Mysid shrimp (<i>Mysidopsis bahia</i>)	28-day NOAEC = 44 LOAEC = 88	46473301 Supplemental	↓4.5% male body length, numerous deviations from guideline.
Freshwater invertebrate (sediment)					
Sub-chronic (10-d)	TGAI (97)	Freshwater midge (<i>Chironomus tentans</i>)	10-day sediment (mg/kg): NOAEC (mortality) = 830 LOAEC = 1700 Pore water (µg a.i./L): NOAEC = 2300 LOAEC = 4100	46478301 Acceptable	16% mortality at highest treatment concentration (LOAEC)
Sub-chronic (10-d)	TGAI (97)	Freshwater amphipod (<i>Hyalella azteca</i>)	10-day sediment (mg/kg): NOAEC (mortality) = 160 LOAEC = 360 Pore water (µg a.i./L): NOAEC = 810 LOAEC = 1100	46487303 Supplemental	45% mortality at highest treatment concentration (LOAEC); body weight not evaluated
Aquatic plants and algae					
Vascular	TGAI (97.5)	Duckweed (<i>Lemna gibba</i>)	7-d EC ₅₀ = 41	41610107 Acceptable	↓ Frond number
Non-vascular	TGAI (97.5)	Freshwater green algae (<i>Selenastrum capricornutum</i>)	120-h EC ₅₀ = 7.8	41610108 Supplemental	↓ Cell density; downgraded due to tested concentrations not low enough to achieve NOAEC

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value in µg a.i./L (unless otherwise specified) ¹	MRID or ECOTOX No./ Classification	Comments (see item 1 above)
	TGAI (97.5)	Freshwater diatom (<i>Navicula pelliculosa</i>)	120-h EC ₅₀ = 126	41610106 Acceptable	↓ Cell density
	TGAI (97.5)	Marine diatom (<i>Skeletonema costatum</i>)	120-h EC₅₀ = 5.2	41610105 Acceptable	↓ Cell density

TGAI=Technical Grade Active Ingredient; TEP= Typical end-use product; a.i.=active ingredient

^N Studies submitted since the problem formulation was completed are designated with an N associated with the MRID number.

Bolded rows indicate endpoints used in risk estimation.

¹ NOAEC and LOAEC are reported in the same units.

>Greater than values designate non-definitive endpoints where no effects were observed at the highest level tested, or effects did not reach 50% at the highest concentration tested (USEPA, 2011).

< Less than values designate non-definitive endpoints where growth, reproductive, and/or mortality effects are observed at the lowest tested concentration.

6.2 Terrestrial Toxicity

There are multiple studies available to evaluate the acute oral, dietary, and chronic toxicity of oxadiazon to birds. Oxadiazon was demonstrated to be practically non-toxic to birds on an acute oral and sub-acute dietary basis, with non-definitive endpoints determined in all available studies. Chronic toxicity studies showed differential results for varying species, with no effects observed in the available mallard duck study, but 25% mortality at the highest treatment level in the available bobwhite quail study.

Similarly, the available acute oral toxicity study for mammals showed a non-definitive (*i.e.* ">") result and the classification of practically non-toxic on an acute oral exposure basis. In the available 2-generation chronic mammalian reproduction study, there were no significant effects on any reproductive parameter or body weight endpoint for both the parental and F₁ generations. The NOAEL was determined to be the highest treatment level.

The Problem Formulation recommended the full suite of Tier I honey bee data for oxadiazon. Subsequently, acute contact, acute oral, and chronic oral studies were submitted and evaluated for adult honey bees, as well as a chronic study for larval honey bees. The acute contact and acute oral studies determined endpoints that classifies oxadiazon as practically non-toxic to bees on acute contact and acute oral exposure routes. In the chronic oral study with honey bee adults, there 62% mortality observed at the highest treatment concentration. It is noted that this study was conducted with a formulated product while it is recommended that technical grade active ingredient is used. A chronic larval study for honey bees resulted in a 24 % decrease in emergence coinciding with a 22% increase in mortality at the LOAEC. There was no acute larval study for honey bees available.

In the available terrestrial plant studies for seedling emergence and vegetative vigor, various species of monocot and dicot plants were exposed to oxadiazon application rates of up to nominal rates of 2.98 lbs a.i./A. In the seedling emergence study, oat and lettuce were the most sensitive monocot and dicot species, respectively, with reductions in mean dry weight being the most sensitive endpoint for both species. This study indicated that monocots and dicots were of similar sensitivity (monocot EC₂₅ = 0.035 lbs a.i./A; dicot EC₂₅ = 0.027 lbs a.i./A) to the effects of oxadiazon on seedling emergence. In the available study on vegetative vigor, ryegrass and lettuce were the most monocot and dicot species, respectively. In contrast to the seedling emergence study, the most sensitive dicot (EC₂₅ = 0.049 lbs a.i./A) was approximately an order of magnitude more sensitive than the most sensitive monocot (EC₂₅ = 0.37 lbs a.i./A). In both studies, there were also significant effects observed in plant height for all species at varying test levels.

Table 6-2. Terrestrial Toxicity Endpoints Selected for Risk Estimation for Oxadiazon

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value ¹	MRID or ECOTOX No./ Classification	Comments
Birds (surrogates for terrestrial amphibians and reptiles)					
Acute Oral	TGAI (97.5)	Bobwhite quail (<i>Colinus virginianus</i>)	14-d LD ₅₀ = >2150 mg a.i./kg-bw	41610101 Acceptable	Practically non-toxic
	TGAI (97.5)	Canary (<i>Serinus canaria</i>)	14-d LD ₅₀ = >2000 mg a.i./kg-bw	50203501 Acceptable (N)	Practically non-toxic
Sub-acute dietary	TGAI (97.5)	Bobwhite quail (<i>Colinus virginianus</i>)	8-d LC ₅₀ = >5000 mg a.i./kg-diet	41610101 Acceptable	Practically non-toxic
	TGAI (97.5)	Mallard duck (<i>Anas platyrhynchos</i>)	8-d LC ₅₀ = >5000 mg a.i./kg-diet	41610103 Acceptable	Practically non-toxic
Chronic	TGAI (97.5)	Bobwhite quail (<i>Colinus virginianus</i>)	20-wk: NOAEC = 500; LOAEC = 1000 mg/kg-diet	41993202 Acceptable	25% of test birds suffered mortality at highest treatment level.
	TGAI (97.5)	Mallard duck (<i>Anas platyrhynchos</i>)	20-wk: NOAEC = 1000; LOAEC = >1000 mg/kg-diet	41993201 Acceptable	No effects observed
Mammals					
Acute Oral	TGAI (97.5)	Laboratory rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 5000 mg a.i./kg-bw	41866501 Acceptable	Practically non-toxic
Chronic (2-generation reproduction)	TGAI (96.6)	Laboratory rat (<i>Rattus norvegicus</i>)	2-generation NOAEL = 15.5 mg a.i./kg-bw/day	41239801 Acceptable	No significant effects in any reproductive parameters or body weight in both generations.
Terrestrial invertebrates					

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value ¹	MRID or ECOTOX No./ Classification	Comments
Acute contact (adult)	TGAI (95.9)	Honey bee (<i>Apis mellifera</i> L.)	48-h LD ₅₀ = >25 µg a.i./bee	42468301 Acceptable	--
	TGAI (95.9)	Honey bee (<i>Apis mellifera</i> L.)	48-h LD₅₀ = >100 µg a.i./bee	49984304 Acceptable (N)	Practically non-toxic
Acute oral (adult)	TGAI (95.9)	Honey bee (<i>Apis mellifera</i> L.)	LD ₅₀ = >111 µg a.i./bee	49984304 Acceptable (N)	Practically non-toxic
Chronic oral (adult)	TEP (33.8)	Honey bee (<i>Apis mellifera</i> L.)	Concentration based (µg a.i./kg diet) NOAEC = 2148, LOAEC = 4478 Dose based (µg a.i./bee/day) NOAEL = 43.4, LOAEL = 61.4	50580802 Supplemental (N)	↑ 62% mortality; formulated product used
Acute oral (larval)	No study available, 50% mortality not observed at any level at the 8-day mortality check within the 22-day chronic larval study.				
Chronic oral (larval)	TGAI (99.5)	Honey bee (<i>Apis mellifera</i> L.)	Concentration based (µg a.i./ kg diet) NOAEC = 133, LOAEC = 242 Dose based (µg a.i./bee/day) NOAEL = 5.43, LOAEL = 9.75	50580801 Acceptable (N)	↓ 24% emergence, ↑ 22% 15-day mortality
Terrestrial and wetland plants					
Vegetative Vigor	TEP (49.6)	Various species	Dicots (lettuce): EC ₂₅ = 0.05 lb a.i./acre Monocots (ryegrass): EC ₂₅ = 0.37 lb a.i./acre	46676503 Acceptable	Both monocot and dicot species endpoints based on effects to dry weight
Seedling Emergence	TEP (49.6)	Various species	Dicots (lettuce): EC ₂₅ = 0.027 lb a.i./acre Monocots (oat): EC ₂₅ = 0.035 lb a.i./acre	46676502 Acceptable	Both monocot and dicot species endpoints based on effects to dry weight

TGAI=Technical Grade Active Ingredient; TEP= Typical end-use product; a.i.=active ingredient

^N Studies submitted since the problem formulation was completed are designated with an N associated with the MRID number.

Bolded rows indicate most sensitive endpoint used in risk estimation.

¹ NOAEC and LOAEC are reported in the same units.

>Greater than values designate non-definitive endpoints where no effects were observed at the highest level tested, or effects did not reach 50% at the highest concentration tested (USEPA, 2011).

< Less than values designate non-definitive endpoints where growth, reproductive, and/or mortality effects are observed at the lowest tested concentration.

6.3 Incident Data

The Incident Data System (IDS) provides information on the available ecological pesticide incidents, including those that have been aggregately reported to the EPA that reported since registration to when the database was searched in February 2020. **Table 6-3** provides a listing of the available incident data. There have been no reported wildlife incidents since the time of the Problem Formulation.

For the sole incident reported since the time of the Problem Formulation that was assigned a Certainty index above “unlikely.” To comply with 6(a)2 requirements, Scotts Company reported a complaint from a golf course in Fort Worth, TX, that Ronstar had damaged 30 acres of Tifsport Bermuda fairways. The report specified 30 acres of damage where fairways had severe turf burn in overlap areas where the product had been applied.

Table 6-3. Oxadiazon Incidents from the Incident Data System (IDS)

Incident Number	Year	State	Product and Additional Active Ingredients	Legality	Certainty Index	Use Site	Species	Magnitude / Other Notes
Plant								
I012094-001	2001	TX	Ronstar	Registered Use	Possible	Turf, golf course	Grass	30 acres

7 Analysis Plan

7.1 Overall Process

This assessment uses a weight of evidence approach that relies heavily, but not exclusively, on a risk quotient (RQ) method. RQs are calculated by dividing an estimate environmental concentration (EEC) by a toxicity endpoint (*i.e.*, EEC/toxicity endpoint). This is a way to determine if an estimated concentration is expected to be above or below the concentration associated with the effect’s endpoint. The RQs are compared to regulatory levels of concern (LOCs). The LOCs for non-listed species are meant to be protective of community-level effects. For acute and chronic risks to vertebrates, the LOCs are 0.5 and 1.0, respectively, and for plants, the LOC is 1.0. The acute and chronic risk LOCs for bees are 0.4 and 1.0, respectively. In addition to RQs, other available data (*e.g.*, incident data) can be used to help understand the potential risks associated with the use of the pesticide.

Exposure was evaluated for oxadiazon limited use patterns with special attention to types of application (liquid foliar spray and granular broadcast). This was done because most of oxadiazon products are formulated/used as granules from which exposure, due to drift, is minimal (considered zero by default).

7.2 Modeling

Various models¹³ are used to calculate aquatic and terrestrial EECs (see **Table 7-1**. The specific models used in this assessment are discussed further below.

Table 7-1. List of the Models Used to Assess Risk

Environment	Taxa of Concern	Exposure Media	Exposure Pathway	Model(s) or Pathway
Aquatic	Vertebrates/ Invertebrates (including sediment dwelling)	Surface water and sediment ¹	Runoff and spray drift to water and sediment	PRZM-VVWM with PWC version 1.52 ²
	Aquatic Plants (vascular and nonvascular)			
Terrestrial	Vertebrate	Dietary items	Ingestion of residues in/on dietary items as a result of direct foliar application	T-REX version 1.5.2 ³
		Consumption of aquatic organisms	Residues taken up by aquatic organisms	KABAM version 1.0 ⁴
	Plants	Spray drift/runoff	Runoff and spray drift to plants	TERRPLANT version 1.2.2
	Bees and other terrestrial invertebrates	Contact Dietary items	Spray contact and ingestion of residues in/on dietary items as a result of direct application	BeeREX version 1.0
All Environments	All	Movement through air to aquatic and terrestrial media	Spray drift	AgDRIFT version 2.1.1 (Spray drift)

¹ Sediment analysis is recommended when the soil-water distribution coefficient (K_d) ≥ 50 -L/kg-soil; the $\log K_{ow} \geq 3$; or the $K_{oc} \geq 1000$ L/kg-organic carbon. Analysis of risk in sediment from exposure in pore water may also occur if aquatic invertebrates are particularly sensitive, as it is expected that RQs will exceed LOCs even if the sediment is not the primary exposure media.

² The Pesticide in Water Calculator (PWC) is a Graphic User Interface (GUI) that estimates pesticide concentration in water using the Pesticide Root Zone Model (PRZM) and the Variable Volume Water Model (VVWM).

³ The Terrestrial Residue Exposure (T-REX) Model is used to estimate pesticide concentration on avian and mammalian food items.

⁴ The K_{ow} based Aquatic Bioaccumulation Model (KABAM) is used to estimate exposure to terrestrial animals that may consume aquatic organisms when a chemical has the potential to bioconcentrate or bioaccumulate. The general triggers for running this model is that: the pesticide is a non-ionic, organic chemical; the $\log K_{ow}$ value is between 3 and 8; and the pesticide has the potential to reach aquatic habitats.

¹³ URL for models used in risk assessment: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment>

8 Aquatic Organisms Risk Assessment

8.1 Aquatic Exposure Assessment

8.1.1 Modeling

Surface water aquatic modeling was simulated using the Pesticide in Water Calculator (PWC version 1.52) for use patterns to terrestrial areas. Modeling was executed for the stressor (parent oxadiazon alone). Chemical input parameters used for modeling were selected as per guidance¹⁴ and are summarized in **Table 8-1** for the stressor.

Table 8-1. Aquatic Modeling Input Parameters for the Chemical Tab for Oxadiazon

Parameter (units)	Value (s)	Study MRID ¹	Comments
K _{oc} (mL/g)	3268	41898202	Highest K _{foc} was used ²
Water Column Metabolism t ½ (days) @ 25°C	551	46594701 49405201 ^N	Represents the 90 percent upper confidence bound on the mean (n=2); Marine sediment study excluded
Benthic Metabolism t ½ (days) @ 25°C	Stable	42773802	Represents the 90 percent upper confidence bound on the mean (n=2)
Aqueous Photolysis t ½ (days)@ pH 5 and 40°N	2.75	41897201	One measured value
Hydrolysis Half-life @ pH 7 (days)	Stable	41863603	One measured value
Soil Half-life (days) at 25°C	888	42773801 50130701 ^N	Represents the 90 percent upper confidence bound on the mean (n= 4)
Molecular Weight (g/mol)	345.20	Chemical profile	
VP (Torr) at 25°C	7.76 × 10 ⁻⁷	MRID 41230301	
Solubility in Water (mg/L) at 25°C	0.70	MRID 41474201	
Heat of Henry (J/mol) @ 25°C	35,620	Calculated for Oxadiazon from EPIWEB 4.1	

¹ Studies submitted since the Problem Formulation was completed are designated with an ^N in association with the MRID number

² Highest observed K_{foc} was used in modeling instead of the average based on a leaching study and terrestrial field dissipation studies. Refer to text below this Table for more details.

Sorption is one of the inputs in modeling that influence pesticide partitioning and transport of the chemical. Based on adsorption/desorption data, oxadiazon is classified as moderately mobile with K_{foc} values for four soils ranging from 1,409 to 3,268 ml/g (MRID 41898202). However, a leaching study, with another four soils, showed that the chemical is immobile (MRID 41889501). In this study, oxadiazon-¹⁴C was applied to the top of 30 cm soil columns and leached with 1,040 ml of 0.005 M CaCl₂ at a rate not exceeding the infiltration capacity of the test soils. Results show that most of the radioactivity remained in the top 6 cm of the soil columns. Radioactivity reached an average of 10% in the 6-12 cm layer and 1% in the 12-24 cm

¹⁴ **Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides URL:**
<https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/guidance-selecting-input-parameters-modeling>

layer in low organic carbon sand and sandy loam soils (O.C <1%). In relatively higher organic carbon sandy loam and loam soils (O.C >1 to 3%) only 0.05% and 0.08% of the applied radioactivity reached 6-12 cm and 12-24 cm layers, respectively. No detection of radioactivity was observed in all soils below 24 cm (**Figure 8-1**) and only 0.1% of the radioactivity was observed in the leachate. No degradation was observed and therefore measured radioactivity represent oxadiazon. Based on this data, oxadiazon can be considered as immobile with a registrant calculated a Kd of 250 ml/g for all soils tested.

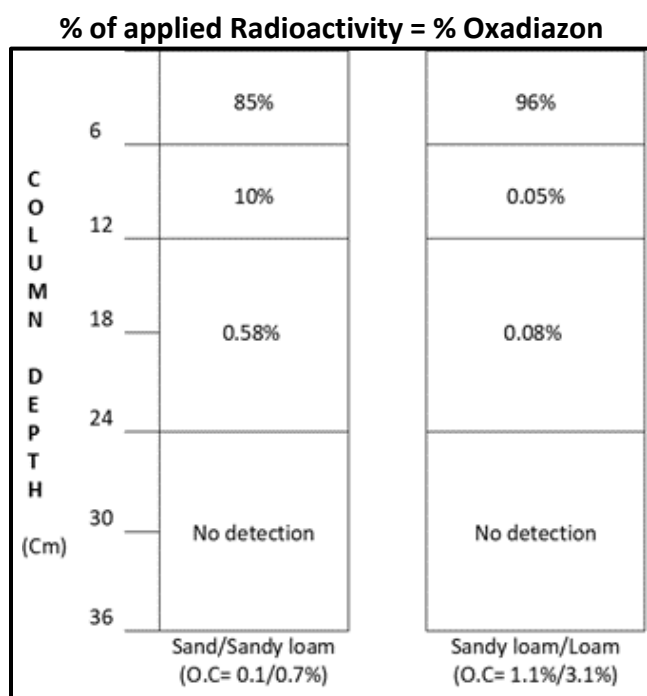


Figure 8-1. A Summary of Soil Column Leaching Study for Oxadiazon

Additionally, a limited degree of leaching was observed in two terrestrial field dissipation studies. In these studies, oxadiazon was detected only in the top 15 cm of the soils, with occasional small detections in the 15-30-cm layers.

Data presented on soil column leaching and the observed limited leaching in the terrestrial field dissipation study can be used as two lines of evidence to support the use of the highest measured Kfoc in surface water modeling instead of the average value (Kfoc of 3,268 ml/g instead of 2,357 ml/g).

Use sites and application parameters were chosen based on the use information described in **Section 3.2**. PWC scenario(s) was/were chosen for each of the use pattern. It is noted that PWC Scenarios are used to specify soil, climatic, and agronomic practices for the crop. Soil and agronomic data specific to the location are built into the scenario, and a specific climatic weather station providing 30 years of daily weather values is associated with the location. **Table 8-2** identifies use sites associated with each PRZM scenario used in modeling oxadiazon use patterns.

Table 8-2. PWC Scenarios Representing Use Patterns for Oxadiazon

Use Site	Representative PWC Scenario
Turf ¹	CATurfRLF; FLturfSTD; PA turfSTD; TurfBSS (TX)
Ornamentals: In Nurseries	CAnurserySTD_V2; FLnurserySTD_V2; MlnurserySTD_V2; NJnurserySTD_V2; ORnurserySTD_V2; TNnurserySTD_V2
Ornamentals: Residential Ground Cover	CAresidentialRLF/CAImperviousRLF; ResidentialBSS/ImperviousBSS (TX)
Right-of-Way	CARightofwayRLF_V2/CAImperviousRLF; RightOfWayBSS/ImperviousBSS (TX)

¹ **Turf:** All types of turf specified in section 3.2 as other turf. Golf course fairways use is to be calculated by applying the golf course adjustment factor¹⁵ of 0.286

Other common application parameters used in modeling were:

1. **Application Window:** Preliminary simulations included a batch run of 365-day /multiple scenarios in a 5-day step representing oxadiazon uses starting from scenario emergence date;
2. **Application rates:** Two applications of 4 lbs. a.i./A (4.484 Kg) each per year in 120-day interval applied to soil surface noting that labels call for washing-off any “over the top spray” into the soil surface immediately after application by rain or irrigation; and
3. **Application type:** broadcast by ground equipment only with efficiency/drift of 0.99/0.062. Most oxadiazon products are formulated as granules, therefore, additional modeling runs were executed with 0% drift for uses/scenarios giving minimum/maximum EECs in the drift included runs;
4. **Residential and rights-of-way uses,** were executed for residential/right of way scenarios along with associated impervious scenarios assuming that 5% of the application rate reaches the impervious areas. Daily concentrations obtained from residential/right of way pervious areas and associated impervious areas were combined to arrive at required averages using a post-processing spreadsheet. Daily concentrations were combined using the following equation: $\{[\text{daily EECs for pervious area} \times 0.5 \text{ “assume 50\% pervious area”} \times 0.5 \text{ “assume 50\% of the area is treated”}]\} + \{[\text{daily EECs for impervious area} \times 0.5 \text{ “assume 50\% impervious area”}]\}$. Required 1-in-10-year averages were calculated using the referenced spreadsheet.

It is noted that since the previous ecological risk assessment was completed, new aerobic soil metabolism and aerobic aquatic metabolism data were submitted and evaluated. These new data were incorporated into the risk assessment and resulted in some changes in the aquatic modeling inputs. Additionally, it is now recommended that the daily average value be used to calculate acute risk quotients for aquatic organisms rather than the peak value used in previous risk assessments (USEPA, 2017).

As explained above, preliminary simulations were executed for 365-day window/multiple scenarios in a batch run representing oxadiazon uses. Therefore, output EECs obtained from the

¹⁵ **Golf Course Adjustment Factors for Simulated Aquatic Exposure Concentrations**, EFED Director Memo dated December 7, 2005

run contained 73 averages for each scenario (365 days/5-day steps= 73). From this preliminary data, EECs representing uses were chosen based on possible application windows obtained from labels and application timing from California usage data. The following steps were used to choose minimum/maximum EECs for oxadiazon uses presented in **Table 8-3**:

1. Subsets of EECs was chosen for each use/scenario as follows:
 - a. For turf use: 5-April to 26-March window (one subset each for CA, FL, PA and TX scenarios);
 - b. For nurseries use: 16-March to 16-Apr window (one subset each for CA, MI, NJ, OR and TN scenarios); and
 - c. For residential and right of way uses: 1-12 March; 5-15 June; 4-16 August; and 2-15 November windows (one subset each for CA and TX residential and right of way scenarios);
2. Subsets containing the maximum and minimum EECs were chosen: (FL and PA for turf use; CA and NJ for nurseries use; and CA and TX for residential and right of way uses); and
3. Maximum EECs along with the first date of application for each of the subsets chosen in step 2 are considered to represent the range of exposure for oxadiazon uses and are summarized in **Table 8-3**.

In conclusion, **Table 8-3** contains exposure EECs for wettable powder/liquid formulations applied as liquid foliar/soil surface (with drift) and application of granular products (no drift).

Table 8-3. Surface Water EECs for Oxadiazon (Estimated Using PWC version 1.52)

Use Pattern	State	First Application Date	1-in-10-year Mean EECs (for sediment in µg/Kg dry sediment)						
			Water Column (µg/L)			Pore-Water (µg/L)		Sediment	
			1-day	21-day	60-day	Peak	21-day	Peak	21-day
Exposure EECs with Drift (Broadcast Spray)									
Turf	FL	26-Feb	33.7	27.5	23.90	22.60	22.60	2,961	2,961
	PA	21-Mar	59.3	48.0	41.90	40.90	40.90	5,358	5,358
Golf Course Turf (Fairways Only) ¹	FL	26-Feb	9.6	7.9	6.84	6.46	6.46	847	847
	PA	21-Mar	17.0	13.7	11.98	11.70	11.70	1,532	1,532
Ornamentals in Nurseries	CA	5-Apr	32.9	26.4	23.10	22.10	22.00	2,895	2,882
	NJ	22-Mar	104.0	84.2	76.10	73.40	73.30	9,615	9,602
Ornamentals: Residential Ground Cover	CA	12-Nov	27.0	21.4	18.00	17.00	16.96	2,227	2,222
	TX	10-Jun	28.7	22.5	18.50	17.30	17.30	2,266	2,266
Right-of-Way	TX	11-Mar	53.2	44.6	40.10	38.20	38.20	5,004	5,004
	CA	16-Aug	55.6	48.5	45.20	40.10	40.10	5,253	5,253
Exposure EECs without Drift (Granular Applications)									
Turf	FL	26-Feb	13.0	10.0	8.80	7.84	7.79	1,027	1,020
	PA	21-Mar	32.1	24.1	19.70	19.40	19.30	2,541	2,528
Golf Course Turf (Fairways Only) ¹	FL	26-Feb	3.7	2.9	2.52	2.24	2.23	294	292
	PA	21-Mar	9.2	6.9	5.63	5.55	5.52	727	723
Ornamentals in Nurseries	CA	5-Apr	7.5	4.8	3.58	3.36	3.36	440	440
	NJ	22-Mar	76.0	62.8	54.40	52.70	52.50	6,904	6,878
Ornamentals: Residential Ground Cover	CA	12-Nov	18.9	14.6	12.23	11.41	11.40	1,495	1,493
	TX	10-Jun	24.7	17.7	14.77	12.92	12.89	1,693	1,689
Right-of-Way	TX	11-Mar	47.1	39.7	35.60	33.60	33.60	4,402	4,402

Use Pattern	State	First Application Date	1-in-10-year Mean EECs (for sediment in µg/Kg dry sediment)						
			Water Column (µg/L)			Pore-Water (µg/L)		Sediment	
			1-day	21-day	60-day	Peak	21-day	Peak	21-day
	CA	16-Aug	49.3	42.8	39.30	34.60	34.50	4,533	4,520

¹ Fairways: Calculated using gulf course adjustment factor (GCAF) Of 0.286

Bolded values represent the highest exposure estimates for a given scenario

8.1.2 Monitoring

Non-targeted Surface/Ground/Raw/Treated Waters Data

Monitoring data are useful in that they provide some information on the occurrence of oxadiazon in the environment under existing usage conditions. However, the measured concentrations should not be interpreted as reflecting the upper end of potential exposures unless they were collected in areas with frequent sampling and where usage was occurring. The absence of detections from non-targeted monitoring cannot be used as a line of evidence to indicate exposure is not likely to occur because it is often collected in areas where the pesticide is not used. Additionally, modeling results are not expected to be similar to monitoring results as monitoring does not reflect the modeled conceptual model and the sampling frequency and duration does not reflect what is simulated in modeling.

The following databases and sources were searched for monitoring information on oxadiazon in February, 2020:

- Water Quality Portal (USEPA and USGS)¹⁶
- California Environmental Data Exchange Network (CEDEN) (State Water Resources Control Board, 2015)¹⁷
- United States Department of Agriculture (USDA) PDP database¹⁸.

The available data were obtained from non-targeted general types of routine monitoring in which samples were not targeted to where the pesticide is used. Sampling frequency was irregular, but the detection limits were mostly below 0.0001 µg/L. Samples consist of surface/ground water, raw/treated drinking water. **Table 8-4** and **Figure 8-2** contain summaries of water monitoring data for oxadiazon.

¹⁶ <https://www.waterqualitydata.us/>

¹⁷ <http://www.ceden.org/>

¹⁸ <https://apps.ams.usda.gov/pdp>

Table 8-4. Surface/Ground Water, Raw/Treated Drinking Water Monitoring Results for Oxadiazon

Sites (Dataset Source)	Monitoring Years	Number of samples: Observed Concentration Range (µg/L) ¹	Detection Frequency
Water Samples: Surface Water			
National Water Quality Portal (STORET & NWIS)	1993 -2018	4 Samples: 1.1	3% (286/9,573)
		282 Samples: 0.01- 0.77	
California (CEDEN)	1993-2018	2 Samples: 1.00- 1.86	35% (793/2,279)
		45 Samples: 0.1000- 0.4742	
		746 Samples: 01.0E⁻⁶- 0.04	
California (CA DPR)	1994-2017	2 Samples: 1.53 & 2.62	31% (68/222)
		66 Samples: 0.003- 0.63	
Water Samples: Raw and Treated Waters			
National (PDP database): Raw Surface DW	2004-2013	0.086	0.1% (1/1,448)
National (PDP database): Raw Ground DW	2010-2013	No detection	0% (0/131)
National (PDP database): Treated DW, Source not specified	2004; 2006-2013	0.025 & 0.164	0.1% (2/2,427)

¹ ND= No detection; NR= Not reported

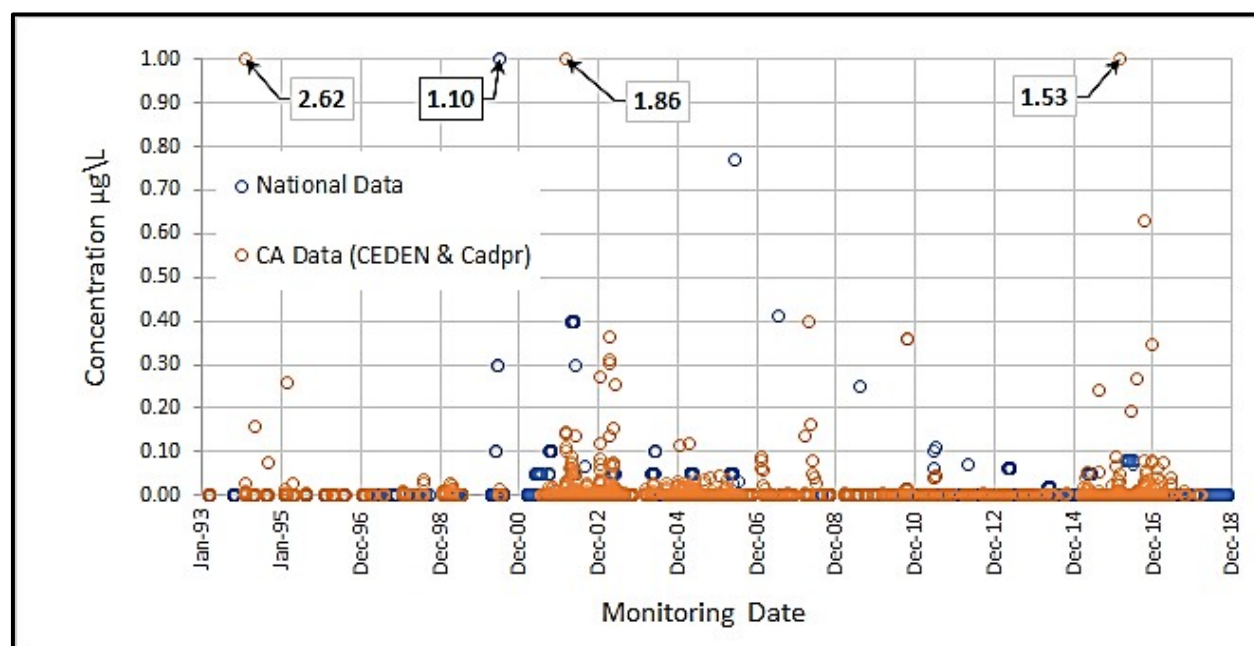


Figure 8-2. Detects in the Water Monitoring data for Oxadiazon with Time.

Data presented in **Table 8-4** and **Figure 8-1** indicate the following:

1. For surface water: The detection frequency was relatively low (3%) for samples obtained at the national level compared to samples from CA (ranged from 31 to 35%). Except for four samples, monitored concentrations were in a relatively low range (nano grams/L to 0.77 ppb). The four samples had the highest monitored concentration and were 1.1 ppb from nationally obtained samples and ranged from 1.53 to 2.62 for CA samples;

2. For raw drinking water (national level data): The detection was 0.1% for 1,448 samples obtained from surface water sources (one sample at 0.086 ppb).
3. For Treated drinking water (national level data, source not reported): The detection frequency was 0.1% for 2,427 samples (two samples at 0.025 and 0.164 ppb); and
4. No apparent change in detection frequency with time from 1993 to 2017. Relatively higher detections/concentrations appear to be in June and December although this might be related to similarity to yearly monitoring schedules.

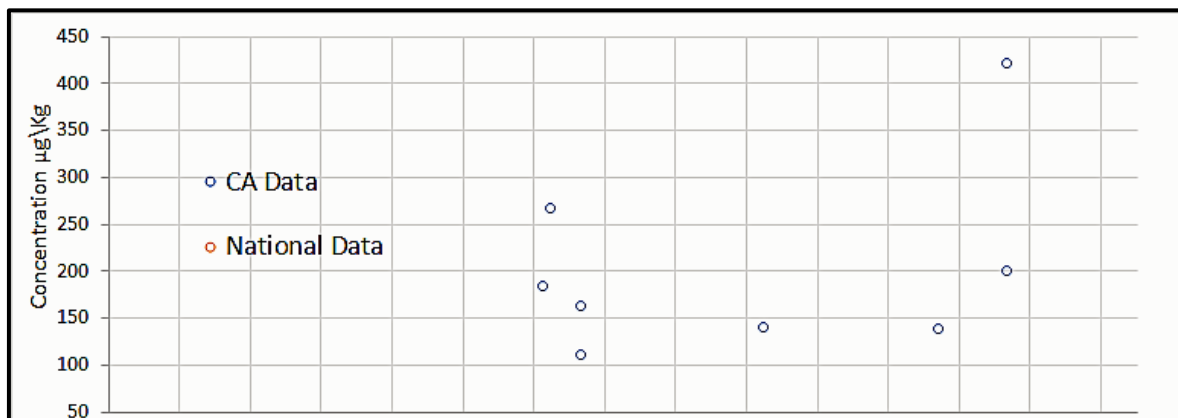
Sediment Data

Table 8-5 and **Figure 8-3** contain data summaries for bottom sediment samples obtained from California sites (899 samples) and sites at the national level (1,009 samples).

Table 8-5. Sediment Monitoring Results for Oxadiazon

Sites (Dataset Source)	Monitoring Years	Number of samples: Observed Concentration Range (µg/Kg)	Detection Frequency ¹
National Water Quality Portal (STORET & NWIS)	1990 - 2018	13 Samples: 11.2- 38.7	5% (50/1,009)
		37 Samples: 1.4- 9.4	
California (CEDEN & CADPR)	2001-2017	10 Samples: 10.3- 422	20% (176/899)
		166 Samples: 0.001- 9.59	

¹ DF= Detection Frequency= Samples with detects/Total number of monitored samples



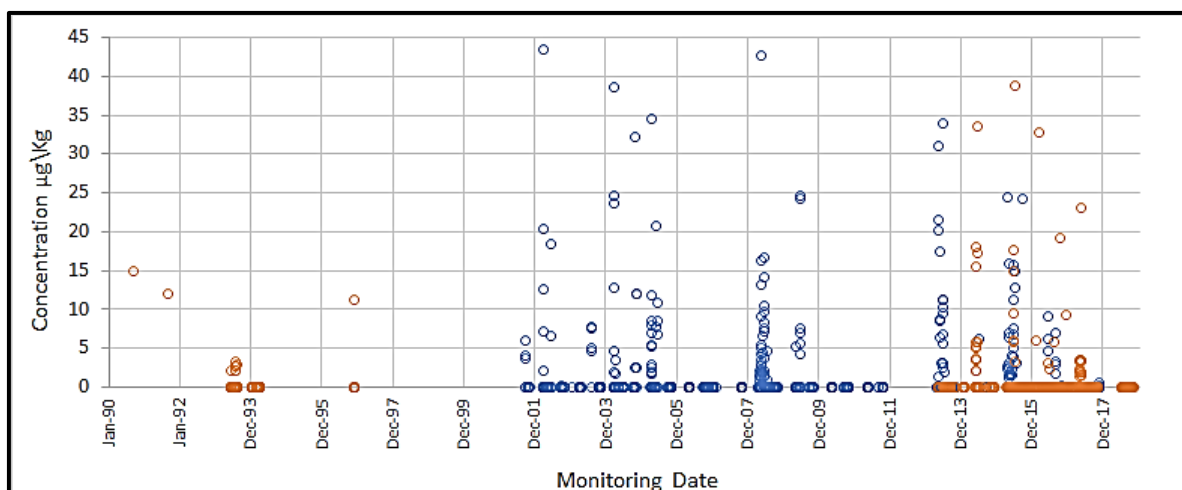


Figure 8-3. Detects in the Sediment Monitoring data for Oxadiazon with Time.

Data presented in **Table 8-5** and **Figure 8-2** indicate that the detection frequency was 5% for national level samples compared to 20% for CA samples. At the national level, the observed concentrations in 26% of the samples were in the range of 11 to 39 ppb, and 75% of the samples in the range of 1.4 to 9.4 ppb. For CA samples, the observed concentrations in 6% of the samples were in the range of 10 to 422 µg/kg, and 94% of the samples in the range of 0.001 to 9.4 ppb.

Golf Course Targeted Surface Water Monitoring Data

The registrant conducted/submitted three years monitoring data (2004 to 2006) targeting golf course use (MRID 4719901). Selection of monitoring sites was based on an earlier FL study (MRID 459201-02) and on a similar approach for NC to identify drinking water watersheds with potential high use of oxadiazon. Results of this study is included herein as an example for data obtained for surface water contamination as a result of Oxadiazon use on golf courses. In this process, the following was considered:

1. Geographic distribution: FL and NC were chosen as they represented 31% of the US total sales in the years 2000 and 2001. However, no sales or usage data were provided for the states nor for chosen areas;
2. Golf course distribution and hydrology: used to establish the existence of golf course run-off contribution to source water of the chosen intakes; and
3. Percent crop area (PCA): used to choose intakes with the highest PCA of golf course areas.

Based on these factors, the drinking water treatment facilities in the cities of Bradenton and West Palm Beach in Florida and the city of Thomasville in North Carolina were selected. Characteristics of chosen sites are summarized in **Table 8-6**.

Table 8-6. Summary Characteristics of Selected Monitoring Sites.

Description ¹ /Site ²	Bradenton, FL	West Palm Beach, FL	Thomasville, NC
City, County, State	Bradenton, Manatee, FL	West Palm Beach, Palm Beach, FL	Thomasville, Davidson, NC
Water Source	Lake Ward	Clear Lake	Tom-A-Lake
Location (Log-Lat)	27.4- -82.4/5	26.6/7- -80.1/3	36.0/1- -80.1
Population Served	35,000	87,466	15,000
Watershed area (Acres)	35,012	129,269	36,125
PCA (Land Cover)	5.54	4.37	Not Available
PCA (Yardage)	1.24	1.03	0.46

¹ **PCA (Land Cover):** Golf course area/total area of the watershed noting that Golf course area was estimated from the area of all recreational grasses in the NLCD; **PCA (Yardage):** Golf course area/total area of the watershed noting that Golf course area was estimated by multiplying the total yardage by a 25-yard assumed average width, and then adding an additional 25% of that total to be conservative

² **Sampling Sites:** Selected sites were those with the highest golf course PCA noting that the number of surface water intakes considered in this process were 24 intakes (PCA ranged from 0 to 5.54) in FL and 30 intakes in NC (PCA ranged from 0.09 to 0.46)

Samples were collected from finished water then raw water in duplicated weekly at Bradenton, FL and Thomasville, NC and Bi-weekly at West Palm Beach, FL. Analysis was conducted using an environmental chemistry method with a limit of detection (LOD) of 0.01 ppb and a limit of quantification (LOQ) of 0.03 ppb. Monitoring results are summarized in **Table 8-7**.

Table 8-7. Summary of Oxadiazon Monitoring Results for Raw and Finished Waters.

Description ¹ /Site		Bradenton, FL	West Palm Beach, FL	Thomasville, NC
Raw Water				
Sampling Frequency (Raw & Finished)		Weekly	Biweekly	Weekly
Number of Detects	≥LOQ	45	0	28
	<LOQ to ≥LOD	79	0	82
Total Number Detects		124	0	110
Total Number of Samples		158	78	153
Detection Frequency % (detects/total)		79%	0%	72%
Highest Monitored Concentration (ppb)		0.175	No detects	0.170

¹ **LOQ:** Limit of quantification= 0.03 ppb; **LOD:** Limit of detection= 0.01 ppb

Data in **Table 8-7** indicate that oxadiazon was not detected at West Palm Beach, FL facility in raw water. In contrast, the chemical was detected in raw water at both Brandon, FL (detection frequency 79%) and Thomasville, NC (detection frequency 72%) with a highest observed concentration of 0.175 and 0.170 ppb, respectively. In general, concentrations above the LOQ were observed between March and June in both raw and finished water samples.

The registrant three years monitoring data might be considered targeted for golf course use of oxadiazon. It is noted however, that no usage data were reported to support the claim that oxadiazon usage is the highest in areas chosen for monitoring.

8.2 Aquatic Organism Risk Characterization

8.2.1 Aquatic Vertebrates

Acute and chronic risk to freshwater and estuarine/marine fish resulting from the registered uses of oxadiazon were estimated using the daily and 60-day mean values were compared to available acute and chronic toxicity data, respectively. Since oxadiazon can be applied as a flowable ground spray or as a granule, EECs and their resultant RQs were estimated using variable drift assumptions.

For acute risk to both freshwater and estuarine/marine fish when considering drift, RQs for all modeled scenarios for the turf and ornamental uses were all below LOC. Since all acute RQs when considering drift were below LOC, acute RQs without drift were not estimated as these EECs, and resultant RQs are lower relative to those with drift.

Chronic risk estimation when considering drift resulted in RQs above the LOC for both freshwater fish (RQs range from **8 - 86**) and estuarine/marine fish (RQs range from **6- 69**) depending on the use pattern. When evaluating the granular formulations of oxadiazon without the assumption of drift, chronic RQs for freshwater fish vary in level of reduction from the RQs with drift considered (RQs range from **3 - 62** but all still exceed the chronic LOC. Similarly, for estuarine/marine fish, all chronic RQs, while reduced from those considering drift, also exceeded the LOC (RQs range from **2 - 49**). Due to the unavailability of a chronic estuarine/marine fish study, an acute-to-chronic ratio was estimated using acute data for freshwater and estuarine/marine fish and chronic data for freshwater fish. This ACR method resulted in an estimated chronic endpoint for estuarine/marine fish of 1.1 µg a.i./L.

Table 8-8. Acute and Chronic Vertebrate Risk Quotients for Non-listed Species

Use Sites	1-in-10 Yr EEC µg/L		Risk Quotient			
			Freshwater		Estuarine/Marine	
	Daily Ave ¹	60-day Ave ²	Acute ³	Chronic ⁴	Acute ⁵	Chronic ⁶
			LC ₅₀ = 1200 µg a.i./L	NOAEC = 0.88 µg a.i./L	LC ₅₀ = 1500 µg a.i./L	NOAEC = No data (ACR of 1.1 µg a.i./L)
Risk Estimation with drift						
Turf (FL)	33.7	23.90	0.03	27	0.02	22
Turf (PA)	59.3	41.90	0.05	48	0.03	38
Golf Course Turf (Fairways Only) (FL)	9.6	6.84	0.01	8.0	<0.01	6.0
Golf Course Turf (Fairways Only) (PA)	17.0	11.98	0.01	14	0.01	11
Ornamentals – Nursery (CA)	32.9	23.10	0.03	26	0.02	21
Ornamentals - Nursery (NJ)	104.0	76.10	0.09	86	0.07	69

Use Sites	1-in-10 Yr EEC µg/L		Risk Quotient			
			Freshwater		Estuarine/Marine	
	Daily Ave ¹	60-day Ave ²	Acute ³	Chronic ⁴	Acute ⁵	Chronic ⁶
			LC ₅₀ = 1200 µg a.i./L	NOAEC = 0.88 µg a.i./L	LC ₅₀ = 1500 µg a.i./L	NOAEC = No data (ACR of 1.1 µg a.i./L)
Ornamentals- Residential Ground Cover (CA)	27.0	18.00	0.02	20	0.02	16
Ornamentals - Residential Ground Cover (TX)	28.7	18.50	0.02	21	0.02	17
Rights-of-way (TX)	53.2	40.10	0.04	46	0.04	36
Rights-of-way (CA)	55.6	45.20	0.05	51	0.04	41
Risk Estimation with no drift						
Turf (FL)	13.0	8.80	Not estimated (drift RQs all below LOC)	10	Not estimated (drift RQs all below LOC)	8
Turf (PA)	32.1	19.70		22		18
Golf Course Turf (Fairways Only) (FL)	3.7	2.52		3.0		2.0
Golf Course Turf (Fairways Only) (PA)	9.2	5.63		6.0		5.0
Ornamentals - Nursery (CA)	7.5	3.58		4.0		3.0
Ornamentals - Nursery (NJ)	76.0	54.40		62		49
Ornamentals- Residential Ground Cover (CA)	18.9	12.23		14		11
Ornamentals - Residential Ground Cover (TX)	24.7	14.77		17		13
Rights-of-way (TX)	47.1	35.60		40		32
Rights-of-way (CA)	49.3	39.30		45		36

Bolded values exceed the LOC for acute risk to non-listed species of 0.5 or the chronic risk LOC of 1.0. The endpoints listed in the table are the endpoint used to calculate the RQ.

¹ The EECs used to calculate this RQ are based on the 1-in-10-year peak 1-day average value from **Table 8-3**.

² The EECs used to calculate this RQ are based on the 1-in-10-year 21-day average value from **Table 8-3**.

³ Freshwater Fish LC₅₀ = 1.2 mg a.i./L (MRID 42360501; Rainbow Trout)

⁴ Freshwater Fish NOAEC = 0.88 mg a.i./L (MRID 41811601; Rainbow Trout)

⁵ Estuarine/marine Fish LC₅₀ = 1.5 mg a.i./L (MRID 42921601; Sheepshead Minnow)

⁶ ACR = Acute to Chronic Ratio calculated using acute and chronic freshwater fish and estuarine/marine fish values

8.2.2 Aquatic Invertebrates

Similar to aquatic vertebrates, acute risk to freshwater and estuarine/marine invertebrates resulting from the registered uses of oxadiazon were below the level of concern for both drift and non-drift scenarios (RQs for no drift were not estimated based on no exceedances for drift). Chronic RQs were marginally above the LOC for certain scenarios across all uses for both freshwater invertebrates (RQs range from 0.3 - **2.8**) and estuarine/marine invertebrates (RQs range from 0.3 - **1.9**). When considering the lack of drift associated with the granule

applications, RQs were reduced relative to those considering drift, but were still in exceedance of the chronic LOC for at least one scenario across all uses (**Table 8-9**).

Table 8-9. Acute and Chronic Aquatic Invertebrate Risk Quotients

Use Sites	1-in-10 Yr EEC µg/L		Risk Quotient			
			Freshwater		Estuarine/Marine	
	Daily Ave ¹	21-day Ave ²	Acute ³	Chronic ⁴	Acute ⁵	Chronic ⁶
			LC ₅₀ >2400 µg a.i./L	NOAEC = 30 µg a.i./L	LC ₅₀ = 270 µg a.i./L	NOAEC = 44 µg a.i./L
Risk Estimation with drift						
Turf (FL)	33.7	27.5	0.01	0.9	0.12	0.63
Turf (PA)	59.3	48.0	0.02	1.6	0.22	1.1
Golf Course Turf (Fairways Only) (FL)	9.6	7.9	<0.01	0.30	0.04	0.18
Golf Course Turf (Fairways Only) (PA)	17.0	13.7	0.01	0.50	0.06	0.30
Ornamentals – Nursery (CA)	32.9	26.4	0.01	0.88	0.12	0.60
Ornamentals - Nursery (NJ)	104.0	84.2	0.04	2.8	0.39	1.9
Ornamentals- Residential Ground Cover (CA)	27.0	21.4	0.01	0.71	0.10	0.49
Ornamentals - Residential Ground Cover (TX)	28.7	22.5	0.01	0.75	0.11	0.51
Rights-of-way (TX)	53.2	44.6	0.02	1.5	0.20	1.0
Rights-of-way (CA)	55.6	48.5	0.02	1.6	0.21	1.1
Risk Estimation with no drift						
Turf (FL)	13.0	10.0	Not estimated (drift RQs all below LOC)	0.33	Not estimated (drift RQs all below LOC)	0.23
Turf (PA)	32.1	24.1		0.80		0.55
Golf Course Turf (Fairways Only) (FL)	3.7	2.9		0.10		0.07
Golf Course Turf (Fairways Only) (PA)	9.2	6.9		0.20		0.16
Ornamentals - Nursery (CA)	7.5	4.8		0.16		0.11
Ornamentals - Nursery (NJ)	76.0	62.8		2.1		1.4
Ornamentals- Residential Ground Cover (CA)	18.9	14.6		0.49		0.33
Ornamentals - Residential Ground Cover (TX)	24.7	17.7		0.59		0.40
Rights-of-way (TX)	47.1	39.7		1.3		0.90
Rights-of-way (CA)	49.3	42.8		1.4		1.0

Bolded values exceed the LOC for acute risk to non-listed species of 0.5 or the chronic risk LOC of 1.0. The endpoints listed in the table are the endpoint used to calculate the RQ.

¹ The EECs used to calculate this RQ are based on the 1-in-10-year peak 1-day average value from **Table 8-3**.

² The EECs used to calculate this RQ are based on the 1-in-10-year 21-day average value from **Table 8-3**.

³ Freshwater Invertebrate LC₅₀ > 2.4 mg a.i./L (MRID 42331801; Water flea)

⁴ Freshwater Invertebrate NOAEC = 30 mg a.i./L (MRID 41784301; Water flea)

⁵ Estuarine/marine Invertebrate LC₅₀ = 0.27 mg a.i./L (MRID 42615802; Mysid shrimp)

⁶ Estuarine/marine Invertebrate NOAEC = 44 mg a.i./L (MRID 46473301; Mysid shrimp)

As indicated previously, there are two sub-chronic (10-day) studies investigating the effects of oxadiazon to freshwater benthic invertebrates. Consistent with the Agency's guidance on assessing the risks associated with benthic invertebrates that examines the various compartments¹⁹ (*i.e.* pore water and sediment) and the potential differential sensitivity of species in these compartments, both water column and sediment toxicity data are utilized for the risk estimation analysis for oxadiazon exposure sediment-dwelling invertebrates. For acute pore water RQs that utilize pore water EECs with water column acute data, there were no RQs estimated due to the lack of definitive acute water column invertebrate endpoints. Using the most sensitive sub-chronic 10-day NOAEC for the available freshwater sediment data, there were no LOC exceedances for benthic freshwater invertebrates in the sediment compartment. For estuarine/marine species, there were no sub-chronic or chronic studies available and therefore the analysis was limited to acute and chronic pore water EEC to water column invertebrate endpoint comparison.

The results of this analysis indicate there were no acute RQs above the LOC and only a marginal exceedance of the chronic LOC for one scenario of ornamentals and the LOC being met with one scenario for the rights-of-way use. For granule formulations of oxadiazon (reported to be 75% of the usage), only a marginal exceedance to one scenario of the ornamental use remains with all other acute and chronic RQs below their respective EECs. It is worth noting that oxadiazon is shown to demonstrate persistence in the soil and sediment environments. While there were few exceedances of the LOC using the currently available sediment data, it is an uncertainty to what extent chronic, longer term studies that examine further reproductive and growth endpoints would show greater toxicity relative to the currently available data. Additionally, it is uncertain to what extent estuarine/marine benthic species are more or less sensitive to oxadiazon relative to freshwater species.

¹⁹ https://www.epa.gov/sites/production/files/2015-08/documents/toxtesting_ecoriskassessmentforbenthicinvertebrates.pdf

Table 8-10. Aquatic Benthic Invertebrate Risk Quotients for Non-listed Species

Use Site	1-in-10 Yr EEC Pore Water ²		1-in-10 Yr EEC Bulk Sediment ²		Risk Quotients			
					Freshwater		Estuarine/marine	
					Acute (Pore Water)	Sub-Chronic (Sediment) ¹	Acute (Pore Water)	Chronic ⁵ (Pore Water)
	Daily	21-day	Daily	21-day	LC/EC ₅₀ >2.400 µg a.i./L ³	NOAEC = 1.6 x 10 ⁵ µg a.i./L ⁴	LC/EC ₅₀ = 270 µg a.i./L ³	NOAEC = 44 µg a.i./L ³
Flowable formulations (drift)								
Turf (FL)	22.60	22.60	2,961	2,961	Not estimated (non-definitive endpoint)	0.02	0.08	0.51
Turf (PA)	40.90	40.90	5,358	5,358		0.03	0.15	0.93
Golf Course Turf (Fairways Only) (FL)	6.46	6.46	847	847		0.01	0.02	0.15
Golf Course Turf (Fairways Only) (PA)	11.70	11.70	1,532	1,532		0.01	0.04	0.27
Ornamentals - Nursery (CA)	22.10	22.00	2,895	2,882		0.02	0.08	0.50
Ornamentals - Nursery (NJ)	73.40	73.30	9,615	9,602		0.06	0.27	1.7
Ornamentals- Residential Ground Cover (CA)	17.00	16.96	2,227	2,222		0.01	0.06	0.39
Ornamentals - Residential Ground Cover (TX)	17.30	17.30	2,266	2,266		0.01	0.06	0.39
Rights-of-way (TX)	38.20	38.20	5,004	5,004		0.03	0.14	0.87
Rights-of-way (CA)	40.10	40.10	5,253	5,253	0.03	0.15	0.91	
Granule formulations (no drift)								
Turf (FL)	7.84	7.79	1,027	1,020		0.01	0.03	0.18
Turf (PA)	19.40	19.30	2,541	2,528		0.02	0.07	0.44
Golf Course Turf (Fairways Only) (FL)	2.24	2.23	294	292		<0.01	0.01	0.05
Golf Course Turf (Fairways Only) (PA)	5.55	5.52	727	723		<0.01	0.02	0.13
Ornamentals - Nursery (CA)	3.36	3.36	440	440		<0.01	0.01	0.08

Use Site	1-in-10 Yr EEC Pore Water ²		1-in-10 Yr EEC Bulk Sediment ²		Risk Quotients			
					Freshwater		Estuarine/marine	
					Acute (Pore Water)	Sub-Chronic (Sediment) ¹	Acute (Pore Water)	Chronic ⁵ (Pore Water)
	Daily	21-day	Daily	21-day	LC/EC ₅₀ >2.400 µg a.i./L ³	NOAEC = 1.6 x 10 ⁵ µg a.i./L ⁴	LC/EC ₅₀ = 270 µg a.i./L ³	NOAEC = 44 µg a.i./L ³
Ornamentals - Nursery (NJ)	52.70	52.50	6,904	6,878		0.04	0.20	1.2
Ornamentals- Residential Ground Cover (CA)	11.41	11.40	1,495	1,493		0.01	0.04	0.26
Ornamentals - Residential Ground Cover (TX)	12.92	12.89	1,693	1,689		0.01	0.05	0.29
Rights-of-way (TX)	33.60	33.60	4,402	4,402		0.03	0.12	0.76
Rights-of-way (CA)	34.60	34.50	4,533	4,520		0.03	0.13	0.78

Bolded values exceed the LOC for acute risk to non-listed species of 0.5 or the chronic risk LOC of 1.0. The endpoints listed in the table are the endpoint used to calculate the RQ.

¹ The EECs used to calculate this RQ are based on the 1-in-10-year 21-day average value from **Table 8-3**. The pore water EEC is listed first in µg/L and the organic-carbon normalized bulk sediment EEC is listed next in µg/kg-OC.

² The EECs used to calculate this RQ are based on OC-normalized values from **Table 8-3** (*i.e.*, the bulk sediment EECs are divided by 0.04 to account for the 4% carbon content of the soil used in the modeling

³ Measured water-column acute value. (>2.4 mg a.i./L for *Daphnia magna*; 270 µg a.i./L for mysid shrimp)

⁴ Most sensitive sediment-based NOAEC (mortality) from study with *Hyalella azteca* (MRID 46487303)

⁵ 21-day pore water / chronic mysid NOAEC (MRID 46473301)

8.2.3 Aquatic Plants

For estimating risk to aquatic plants, the peak EECs for scenarios considering drift and without are compared to the EC₅₀ of the most sensitive vascular and non-vascular aquatic plant species. The available data indicate that vascular aquatic plants are approximately one order of magnitude less sensitive to the effects of oxadiazon relative to non-vascular plants. The RQs associated with vascular aquatic plants and when considering drift resulted in marginal exceedances of the LOC (RQs range from 0.40 - **2.5**) of at least one scenario across all uses of oxadiazon. When evaluating the granular uses (*i.e.* no drift) scenarios of oxadiazon, RQs were marginally above LOC for only the rights-of-way and ornamental uses.

Given the increased sensitivity to oxadiazon relative to vascular aquatic plants, RQs for non-vascular aquatic plants exceeded the LOC for all scenarios and uses both with drift included and excluded (RQs range from **3.0** - **20** with drift; 0.7 - **15** as a granule) (**Table 8-11**). There are currently no reported incidents for oxadiazon to aquatic plants.

Table 8-11. Aquatic Plant Risk Quotients for Non-listed Species

Use Sites	1-in-10 Year Daily Average EEC µg/L ¹	Risk Quotients	
		Vascular	Non-vascular
		IC ₅₀ = 41 µg a.i./L ²	IC ₅₀ = 5.2 µg a.i./L ³
Risk Estimation with drift			
Turf (FL)	33.7	0.82	6.5
Turf (PA)	59.3	1.5	11
Golf Course Turf (Fairways Only) (FL)	9.6	0.23	1.8
Golf Course Turf (Fairways Only) (PA)	17.0	0.40	3.0
Ornamentals – Nursery (CA)	32.9	0.80	6.3
Ornamentals - Nursery (NJ)	104.0	2.5	20
Ornamentals- Residential Ground Cover (CA)	27.0	0.66	5.2
Ornamentals - Residential Ground Cover (TX)	28.7	0.70	5.5
Rights-of-way (TX)	53.2	1.3	10
Rights-of-way (CA)	55.6	1.4	11
Risk Estimation with no drift			
Turf (FL)	13.0	0.32	2.5
Turf (PA)	32.1	0.78	6.2
Golf Course Turf (Fairways Only) (FL)	3.7	0.09	0.70
Golf Course Turf (Fairways Only) (PA)	9.2	0.22	1.8
Ornamentals - Nursery (CA)	7.5	0.18	1.4
Ornamentals - Nursery (NJ)	76.0	1.9	15

Use Sites	1-in-10 Year Daily Average EEC µg/L ¹	Risk Quotients	
		Vascular	Non-vascular
		IC ₅₀ = 41 µg a.i./L ²	IC ₅₀ = 5.2 µg a.i./L ³
Ornamentals- Residential Ground Cover (CA)	18.9	0.46	3.6
Ornamentals - Residential Ground Cover (TX)	24.7	0.60	4.8
Rights-of-way (TX)	47.1	1.1	9.0
Rights-of-way (CA)	49.3	1.2	9.0

The LOC for non-listed plants is 1. The endpoints listed in the table are the endpoint used to calculate the RQ.

¹ The EECs used to calculate this RQ are based on the 1-in-10-year peak 1-day average value from **Table 8-3**.²

Vascular plant IC₅₀ = (MRID 41610107; *Lemna gibba*)

³ Non-vascular plant IC₅₀ = (MRID 41610105; *Skeletonema costatum*, marine diatom)

8.3 Aquatic Organism Risk Summary

Based on the available toxicity data and modeled EECs determined for representative uses of oxadiazon, there were no acute risks above the LOCs identified for fish and aquatic invertebrates across all registered uses.

Chronic risk to freshwater fish was based on NOAEC of 0.88 µg a.i./L. If the RQs were estimated using the LOAEC of 1.7 µg a.i./L, the concentrations where a 9.8% reduction in survival was observed, they would be above the LOC for all scenarios, use patterns and formulations. Unlike the NOAEC, the LOAEC is a concentration for which effects were observed in experimental studies. Notably, the high ultra-light test for chronic freshwater fish did not result in the most sensitive endpoint for oxadiazon, however it was conducted using a fathead minnow which tends to be a less sensitive species. Despite this, the LDPH study showed an increase in sensitivity of an order or magnitude, and thus suggests a greater potential for effects in the rainbow trout. As an LDPH herbicide, oxadiazon's toxicity is further potentiated by enhanced light conditions, such as in clear shallow waters. It is noted that while clear shallow waters would also facilitate a rapid (half-life of less than 3 days), these conditions are not always present in all waterways.

Additional characterization cannot be explored for estuarine/marine fish based on a lack of data. Chronic risk to estuarine/marine fish is based on a calculated acute-to-chronic ratio, calculated using data for the freshwater fish. Acute toxicity values for freshwater fish (1.2 mg a.i./L) are similar to acute toxicity values for estuarine/marine fish (1.5 mg a.i./L). Therefore, it can be expected that the results of the LOAEC analysis for freshwater fish may also apply to estuarine/marine fish.

The available data show aquatic invertebrates to be within an order of magnitude in sensitivity relative to fish on an acute basis and one to two orders of magnitude less sensitive on a chronic basis. As a result, the chronic LOC exceedances for aquatic invertebrates were lower in magnitude and were not concluded for every scenario and use, as was the case with fish. Specifically, the freshwater invertebrate chronic risk estimation analysis was based on a 4.7%

reduction in reproduction at the LOAEC. If the LOAEC was used for risk estimation purposes (level at which reductions were empirically observed), the resultant flowable formulation RQs would only exceed for one scenario in nursery ornamentals and meet the LOC for turf and rights-of way. For granular applications, one RQ associated with a nursery ornamental scenario would marginally exceed the LOC, with all other chronic freshwater RQs falling below LOC.

The LOC exceedances for aquatic plants is somewhat anticipated given oxadiazon's use as an herbicide. Granule formulations generally decreased the RQs to varying degrees, depending on the scenario, but RQs exceeded the LOC for non-vascular aquatic plants for every scenario and every use for both flowable and granular formulations.

There were no incidents for any aquatic taxa that have been reported for oxadiazon.

The available monitoring data suggest that the upper end of detected concentrations are in the range of freshwater chronic fish LOAEC values (1.7 µg a.i./L). Specifically, although the majority of National level samples from the NWIS database were below the LOD (3% detections total), there were 4 samples that ranged from 1.1 - 1.9 µg a.i./L. Additionally, data from California, which had detections frequency ranging from 33 - 35% (depending on the source) noted 2 samples near this threshold ranging from 1.5 - 2.6 µg a.i./L. All other detects were lower, and the majority below the NOAEC for chronic freshwater fish as well as acute LC₅₀ values. It is noted that the monitoring data were largely untargeted and therefore, for a given sample, it is not known where the use area was or the associated application rate.

9 Terrestrial Vertebrates Risk Assessment

9.1 Terrestrial Vertebrate Exposure Assessment

Terrestrial wildlife exposure estimates are typically calculated for birds and mammals by emphasizing the dietary exposure pathway. Oxadiazon is applied through ground application methods, which includes sprayers, chemigation and soil drenching, as well as through granule applications. Therefore, potential dietary exposure for terrestrial wildlife in this assessment is based on consumption of oxadiazon residues on food items following spray (foliar or soil) applications, and from possible dietary ingestion of oxadiazon residues on treated granules. EECs for birds²⁰ and mammals from consumption of dietary items on the treated field were calculated using T-REX v.1.5.2. Terrestrial wildlife may also be exposed through ingestion of residues in aquatic organisms. Exposure through this pathway was evaluated using KABAM.

9.1.1 Dietary Items on the Treated Field

Potential dietary exposure for terrestrial wildlife in this assessment is based on consumption of oxadiazon residues on food items following spray (foliar or soil) applications, and from possible

²⁰ Birds are also used as a proxy for reptiles and terrestrial-phase amphibians.

dietary ingestion of oxadiazon residues on treated granules. Data was not available to estimate the foliar dissipation half-life, therefore the default assumption of 35 days was used for modeling. EECs for birds²¹ and mammals from consumption of dietary items on the treated field were calculated using T-REX v.1.5.2. For the foliar uses, EECs are based on application rates, number of applications, and intervals presented in **Table 3-1**.

Upper-bound Kenaga nomogram values are used to derive EECs for oxadiazon exposures to terrestrial mammals and birds on the field of application based on a 1-year time period. Consideration is given to different types of feeding strategies for mammals, including herbivores, insectivores and granivores. Dose-based exposures are estimated for three weight classes of birds (20 g, 100 g, and 1,000 g) and three weight classes of mammals (15 g, 35 g, and 1,000 g). EECs on terrestrial food items range from 410 to 1,049 mg/kg-diet based on upper bound Kenaga values. Dose base EECs, adjusted for body weight, range from 4.24 to 681.38 for birds and 2.23 to 691.34 for mammals. A summary of EECs is provided in **Table 9-1**.

Additionally, oxadiazon has registered uses as a granule for both turf and ornamental uses. Granular assessments in T-REX are limited to the acute route of exposure through the LD₅₀/ft² methodology. Conceptually, an LD₅₀/ft² is the amount of pesticide estimated to kill 50% of exposed animals in each square foot of applied area. Although a square foot does not have a defined ecological relevance, and any unit area could be used, risk presumably increases as the LD₅₀/ft² value increases. The LD₅₀/ft² method is calculated using a toxicity endpoint (the adjusted LD₅₀) and the EEC mg a.i./ft² and is directly compared with the Agency's level of concern. The EEC from granular applications to ornamentals is 41.65 mg a.i./square foot; the final LD₅₀/ft² was not calculated because the acute endpoints for both birds and mammals are non-definitive.

²¹ Birds are also used as a proxy for reptiles and terrestrial-phase amphibians.

Table 9-1. Summary of Dietary (mg a.i./kg-diet) and Dose-based EECs (mg a.i./kg-bw) as Food Residues for Birds, Reptiles, Terrestrial-Phase Amphibians and Mammals from Labeled Uses of Oxadiazon (T-REX v. 1.5.2, Upper Bound Kenaga)

Food Type	Dietary-Based EEC (mg/kg-diet)	Dose-Based EEC (mg/kg-body weight)					
		Birds			Mammals		
		Small (20 g)	Medium (100 g)	Large (1000 g)	Small (15 g)	Medium (35 g)	Large (1000 g)
Ornamentals (nursery), ornamentals (residential ground cover), turf, rights-of-way (4 lbs a.i./A x2; 120-day interval)							
Short grass	1049.16	1194.89	681.38	305.06	1000.29	691.34	160.29
Tall grass	480.86	547.66	312.30	139.82	458.47	316.86	73.47
Broadleaf plants/small insects	590.15	672.12	383.27	171.60	562.67	388.88	90.16
Fruits/pods/(seeds, dietary only)	65.57	74.68	42.59	19.07	62.52	43.21	10.02
Arthropods	410.92	468.00	266.87	119.48	391.78	270.77	62.78
Seeds (granivore)		16.60	9.46	4.24	13.89	9.60	2.23

Bolded values exceed the LOC for acute risk to non-listed species of 0.5 or the chronic risk LOC of 1.0.

9.1.2 Exposure via Bioaccumulation

Oxadiazon has a log K_{ow} greater than 3 ($K_{ow} = 4.91$), therefore, terrestrial wildlife may also be exposed through ingestion of bioaccumulated residues in aquatic organisms. Exposure through this pathway was evaluated using KABAM.²²

The KABAM model (K_{ow} (based) Aquatic BioAccumulation Model) version 1.0 was used to evaluate the potential exposure and risk of direct effects to birds and mammals via bioaccumulation and biomagnification in aquatic food webs. KABAM is used to estimate potential bioaccumulation of hydrophobic organic pesticides in freshwater aquatic ecosystems and risks to mammals and birds consuming aquatic organisms which have bioaccumulated these pesticides. The bioaccumulation portion of KABAM is based upon work by Arnot and Gobas (2004) who parameterized a bioaccumulation model based on PCBs and some pesticides (e.g., lindane, DDT) in freshwater aquatic ecosystems (Arnot and Gobas, 2004). KABAM relies on a chemical's octanol-water partition coefficient (K_{ow}) to estimate uptake and elimination constants through respiration and diet of organisms in different trophic levels. Pesticide tissue residues are calculated for organisms at different levels of an aquatic food web. The model then uses pesticide tissue concentrations in aquatic animals to estimate dose- and dietary-based exposures and associated risks to mammals and birds (surrogate for amphibians and reptiles) consuming aquatic organisms. Seven different trophic levels including phytoplankton, zooplankton, benthic invertebrates, filter feeders, small-sized (juvenile) forage fish, medium-sized forage fish, and larger piscivorous fish, are used to represent an aquatic food web. Importantly, chemical metabolism by biota is assumed to be zero in KABAM unless evidence indicates such metabolism is likely to affect the model predictions substantially.

In addition to KABAM-predicted bioaccumulation of oxadiazon, a measured BCF of 1,111 L/kg-wet weight fish is available from a registrant-submitted study (MIRD 42226701). It is noted, that oxadiazon undergoes relatively rapid depuration based on the BCF study (50% depuration in about 1 day) and reaches steady state accumulation in 3 days. KABAM predicts steady-state accumulation in 22 days, which suggests that oxadiazon may be undergoing metabolism in fish tissue and/or it is eliminated from fish at a faster rate than KABAM predicts. Typically, measured BCF values are used to evaluate the accuracy of the KABAM-predicted BCFs in order to determine if additional refinements are required (e.g., incorporating empirical measurements of metabolism rate constants derived from the BCF study). However, the submitted BCF study did not report the lipid fraction in the test species. Lack of reported lipid fraction introduces uncertainty when comparing the BCF value with that predicted using KABAM because lipid fraction can vary substantially within and among aquatic species. Based

²² Guidance URL: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/kabam-version-10-users-guide-and-technical>

on an assumed fraction of 4% (mean % lipid in bluegill sunfish from the open literature as summarized in the KABAM User's Guide), the KABAM-predicted BCF on a lipid normalized basis is 96,700 L/kg-lipid. Based on this same assumed 4% lipid fraction in the test species (bluegill sunfish) from the BCF study, the lipid-normalized BCF is 34,100 L/kg-lipid, which is about 1/3 that predicted by KABAM.

This measured lipid-normalized BCF represents accumulation in fish through respiration only. However, even if the RQ values from KABAM were reduced by 1/3 (which assumes all uptake through respiration), risk would still be indicated to all mammalian species on a chronic dose basis and almost all species (with the exception of the water shrew and rice rat) on a chronic dietary basis. Therefore, additional refinement of the KABAM-based bioaccumulation estimates was not conducted.

Input scenarios and parameters were chosen to represent the range of exposures from high to low and are presented in **Table 8-3**. Example output from the bioaccumulation model is provided in **Appendix F**.

Table 9-2. Bioaccumulation Model Input Values for Oxadiazon

Parameter	Input Value	Source
Pesticide Name	Oxadiazon	--
Log K _{ow}	4.91	MRID 41230302
K _{oc} (L/kg)	2,357	Mean K _{oc} value from MRID 41898202
Pore water EEC (µg/L)	77.2	Maximum 1-in-10 year 21-day average value from surface water modeling. The estimated time to reach steady state was 24 days. EECs associated with use on ornamentals (NJ nursery) modeled with drift.
Water column EEC (µg/L)	95.3	Maximum 1-in-10 year 21-day average value surface water modeling. The estimated time to reach steady state was 24 days. EECs associated with use on ornamentals (NJ nursery) modeled with drift.

Maximum 1-in-10-year 21-day average water column EECs for the scenarios explored in aquatic modeling ranged from 5.17 to 95.3. For the KABAM modeling, the EECs associated with oxadiazon use on ornamentals, including drift, were used. Based on KABAM results, estimated concentrations of Oxadiazon residues in the tissue of organisms in the different trophic levels following application to ornamentals range from 270,725 to 647,593 µg/kg-tissue (**Table 9-3**).

Table 9-3. Predicted Concentrations of Oxadiazon in Aquatic Organism Tissues at Different Trophic Levels (µg/kg)

Use Scenario	Phytoplankton	Zooplankton	Benthic Invertebrates	Filter Feeders ¹	Small Fish	Medium Fish	Large Fish
Ornamentals (with drift)	354,257	270,725	300,345	197,293	432,765	497,371	647,593

¹ Filter feeders include clams, krill, sponges, whales, and many fish and may be vertebrates or invertebrates.

9.2 Terrestrial Vertebrate Risk Characterization

Table 9-2 summarizes the acute and chronic RQs for birds resulting from the registered uses of oxadiazon. Acute oral RQs were not estimated for birds and mammals due to the lack of definitive (*i.e.* “>”) endpoints. Avian acute dietary RQs were also not estimated due to non-definitive (*i.e.* “>”) endpoints. If assuming the top concentration was the endpoint, dietary-based EECs are at least 5-fold less than the dietary adjusted endpoints.

For chronic risk, definitive endpoints are available for birds based on a 25% reduction in survival at the highest treatment group. Chronic RQs for birds based on this endpoint exceed the LOC for 2 food items for all registered uses for oxadiazon (RQs range from 0.13 - **2.1**).

For mammals, there was no definitive LOAEC established as there were no significant effects observed up to and including the highest treatment group (200 mg a.i./kg-diet, 15.5 mg a.i./kg-bw). Therefore, chronic RQs were not estimated for mammals. It is noted, however, that dose-based EEC up to 1000 mg a.i./kg-bw and dietary-based EECs up to 1050 mg a.i./kg-diet are 1-2 orders of magnitude higher than the highest levels where effects were not observed in the 2-generation chronic mammal study. Therefore, there is significant uncertainty as to the potential for chronic effects to mammals for the registered uses of oxadiazon due to the available chronic study not elucidating potential effects at relevant field concentrations.

For granular uses, T-REX utilizes an LD₅₀/ft² methodology as described earlier. The toxicity endpoint used for this analysis is the most sensitive body weight adjusted LD₅₀ for birds and mammals. As described previously, the available acute oral studies for both birds and mammals yielded non-definitive endpoints and therefore this analysis is reliant on definitive LD₅₀ endpoints, it was not conducted for this assessment.

Table 9-4. Acute and Chronic RQ values for Birds, Reptiles, and Terrestrial-Phase Amphibians from Labeled Uses of Oxadiazon (T-REX v. 1.5.2, Upper Bound Kenaga)

Food Type	Acute Dose-Based RQ LD ₅₀ >2,150 mg a.i./kg-bw ¹			Acute Dietary- Based RQ LC ₅₀ >5000 mg a.i./kg-diet ²	Chronic Dietary RQ NOAEC = 500 mg a.i./kg- diet ³
	Small (20 g)	Medium (100 g)	Large (1000 g)		
Ornamentals (nursery), ornamentals (residential ground cover), turf, rights-of-way, 4 lbs a.i./A, 2x, 120-day interval					
Herbivores/Insectivores					
Short grass	Not estimated due to non-definitive endpoints				2.1
Tall grass					0.96
Broadleaf plants					1.2
Fruits/pods/seeds					0.13
Arthropods					0.82
Granivores					

Food Type	Acute Dose-Based RQ LD ₅₀ >2,150 mg a.i./kg-bw ¹			Acute Dietary- Based RQ LC ₅₀ >5000 mg a.i./kg-diet ²	Chronic Dietary RQ NOAEC = 500 mg a.i./kg- diet ³
	Small (20 g)	Medium (100 g)	Large (1000 g)		
Seeds	Not estimated due to non-definitive endpoints				

Bolded values exceed the LOC for acute risk to non-listed species of 0.5 or the chronic risk LOC of 1.0. The endpoints listed in the table are the endpoint used to calculate the RQ.

¹ Avian Acute Oral LD₅₀ > 2,150 mg a.i./kg-bw (MRID 41610101; Bobwhite Quail)

² Avian Subacute Dietary LC₅₀ > 5,000 mg a.i./kg-diet (MRID 41610101; Bobwhite Quail)

³ Avian Chronic NOAEC = 500 mg/kg-diet (MRID 41993202; Bobwhite Quail)

To estimate RQs for birds and mammals that ingest residues in aquatic organisms, the KABAM model was used; an example output has been provided in **Appendix F**. Based on the log K_{ow} of 4.91, toxicity information, and model-specific inputs, there is a potential risk associated to some species of birds consuming aquatic species that have been exposed to oxadiazon on a chronic basis. For birds, estimated chronic RQs are below the LOC for most species, with the exception of the white pelican; RQs range from 0.62 to 1.3. The potential for chronic risk to mammals consuming oxadiazon-contaminated food sources was not estimated due to a lack of effects in the available chronic study. As noted previously, there is uncertainty in the chronic mammal risk estimation analysis given that the field food item concentrations were 1-2 orders of magnitude higher relative to the highest concentrations tested in the available 2-generation reproduction study with no effects observed.

Table 9-5. RQ Values for Birds and Mammals Consuming Fish from Oxadiazon Use on Ornamentals, including Drift

RQs for Birds		
Species	Chronic RQ ¹	
	Dose Based	Dietary Based
Sandpipers	N/A	0.62
Cranes	N/A	0.67
Rails	N/A	0.73
Hérons	N/A	0.80
Small osprey	N/A	0.99
White pelican	N/A	1.3

Conc=concentration

¹ Avian Chronic NOAEC = 500 mg/kg-diet (MRID 41993202; Bobwhite Quail)

Based on the available toxicity data and upper bound EECs for terrestrial food items, there were no acute dose and dietary based RQs estimated for birds and mammals due to the presence of non-definitive (*i.e.* ">") endpoints. If it were assumed the LD₅₀ was the top dose in the available acute oral studies, when examining the EECs on various food items, only the short grass EECs

and small sized bird adjusted LD₅₀ are within the same order of magnitude of each other. For all other food items and size classes of birds, food item EECs and adjusted LD₅₀ values had at least one order of magnitude in separation. For acute dietary-based risk to birds, if assuming the LC₅₀ was the top concentration, dietary-based EECs are at least 5-fold less than the dietary adjusted endpoints.

Similarly, acute oral RQs for mammals were not estimated due to non-definitive (*i.e.* ">") endpoints). If the assumption were made that the top dose tested was the definitive endpoint, all food item EECs are at least one order of magnitude in separation from the adjusted LD₅₀ values of the various size classes of mammals. The chronic risk assessment for birds was based on 25% mortality at the highest treatment level. Using the upper bound Kenaga values, there were marginal exceedances of the LOC for two of the evaluated food items. Chronic risk for all food items would fall below the LOC utilizing the mean Kenaga values.

Chronic risk to mammals above the LOC was indicated for both the dose and dietary-based routes of exposure. Dose-based RQs were generally higher relative to dietary-based RQs and exceeded the LOC for most food items and size classes. Notably, there were no significant effects observed in the 2-generation reproduction study up to and including the highest treatment group (15.5 mg/kg-bw/day). Considering the relatively high application rates of oxadiazon (up to 8 lbs a.i./A on an annual basis), the gap between the estimated food item EECs and the highest test concentration in the potential for effects and results in uncertainty of where effects would be observed had the study tested at higher treatment levels.

As mentioned previously, a granular analysis of the registered use of oxadiazon was not conducted due to the lack of definitive endpoints with which to execute an LD₅₀/ft² analysis. There are no reported incidents for any terrestrial vertebrate taxa that are available for oxadiazon.

To determine off-field risk, AgDRIFT was used to calculate exposure from oxadiazon ground applications to ornamentals. The results of this analysis show that for small mammals, risk extends 10 to 27 feet off field and less than 10 feet off field for large mammals.

Table 9-6. Distance Risk Extends off Field for Mammals from Ground Applications of Oxadiazon to Ornamentals

Mammal Size	Boom Length	Dietary Item ²	Droplet Size	Application Rate (Fraction Applied) ²	
				Dose Based (ft)	Dietary Based (ft)
				4 (0.034)	4 (0.189)
Small	Low	Short Grass	VF/F	27	7
	High		F/M-C	10	4
				4 (0.189)	4 (0.476)
Large	Low	Arthropod	VF/F	7	4
	High		F/M-C	4	4

¹Brackets the highest and lowest LOC exceedance

VF/F indicates Very Fine to Fine droplet size

F/M-C indicates Fine to Medium-Coarse droplet size

² Fraction Applied = LOC/RQ. Chronic LOC = 1

10 Terrestrial Invertebrate Risk Assessment

10.1 Terrestrial Invertebrate Exposure Assessment

The risk assessment process for terrestrial invertebrates follows the framework described in the *Guidance for Assessing Pesticide Risks to Bees* (USEPA 2014). This framework is a tiered process, which utilizes available ecotoxicity data at the individual organism level, and where data are available, at the colony level of biological organization. Additionally, field residue data in pollen and nectar are also utilized, where available.

The first step in the tiered process is to determine the potential for exposure to bees. For agricultural use patterns, this is primarily determined using information in the United States Department of Agriculture's *Attractiveness of Agricultural Crops to Pollinating Bees for the Collection of Nectar and/or Pollen* (USDA, 2015). For the registered use patterns for oxadiazon (ornamental, turf, and rights-of-way) the USDA document does not specify attractiveness of these use patterns.

Although not described in the USDA publication, pollinator exposure to ornamentals is potential due to the wide variety of species that comprise this group with pollen and nectar producing flowering plants. While residential turf could potentially be pollinator attractive due to the presence of flowering weeds, oxadiazon is currently registered only on commercial turf areas such as sod farms and the fairways of golf courses. These areas are likely to be more maintained to control for the presence of flowering weeds that are potentially attractive to pollinators. Therefore, only the ornamentals use pattern will be evaluated for terrestrial

invertebrate on-field risk. Because there may be pollinator attractive plants adjacent to turf areas, off-field risk to turf use areas will also be evaluated.

Table 10-1. Summary of Information on the Attractiveness of Registered Use Patterns for Oxadiazon to Bees

Crop Name	Honey Bee Attractive? ^{1,2}	Bumble Bee Attractive? ^{1, 2}	Solitary Bee Attractive? ^{1, 2}	Acreage in the U.S.	Notes
Woody and non-woody ornamentals	Not referenced in the crop attractiveness guide but assumed to be pollinator attractive based on wide variety of flowering species in this group.				

¹ attractiveness rating is a single “+”, denoting a use pattern is opportunistically attractive to bees.

² attractiveness rating is a double “++” denoting a use pattern is attractive in all cases

10.2 Terrestrial Invertebrate Tier I Exposure Estimates

Contact and dietary exposure are estimated separately using different approaches specific for different application methods. The Bee-REX model (Version 1.0) calculates default (*i.e.*, high end, yet reasonably conservative) EECs for contact and dietary routes of exposure for foliar, soil, and seed treatment applications. Further information about the Bee-REX model, including a summary of the methods used for deriving the default Tier I EECs can be found in the User Guide : <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment#terrestrial>. See **Appendix D** for a sample output from Bee-REX for oxadiazon.

Based on the risk assessment guidance, the Tier I acute and chronic risk LOCs for 54 pollinator insects are 0.4 and 1.0, respectively. Furthermore, the European honey bee, *A. mellifera*, is considered a surrogate test species for representation of other non-*Apis* bee species if no other species data are available.

In cases where the Tier I RQs exceed the LOC, estimates of exposure may be refined using measured pesticide concentrations in pollen and nectar of treated crops (provided measured residue data are available), and further calculated for other castes of bees using their food consumption rates as summarized in the White Paper to support the Scientific Advisory Panel (SAP) on the pollinator risk assessment process (USEPA, 2012). If the refined Tier I RQ values exceed levels of concern, then risks may be evaluated at the colony level using Tier II (semi-field) and/or Tier III (full-field) studies). However, with oxadiazon, higher tier effects (colony level) and exposure (residue) data are not available.

10.3 Terrestrial Invertebrate Risk Characterization (Tier I)

10.3.1 Tier I Risk Estimation (Contact Exposure)

On-Field Risk

Since an exposure potential of bees is identified for ornamentals both on and off the treated field, the next step in the risk assessment process is to conduct a Tier 1 risk assessment. By design, the Tier I assessment begins with (high end) estimates of exposure via contact and oral routes. For contact exposure, only the adult (forager and drones) life stage is considered since this is the relevant life stage for honey bees. Furthermore, toxicity protocols have only been developed for acute exposures. Effects are defined by laboratory exposures to groups of individual bees.

Table 10-2. Default Tier 1 Adult, Acute Contact Risk for Honey Bees Foraging on Ornamentals

Use Pattern	Bee Attractiveness	Max. Single Application Rate	Dose (μg a.i./bee per 1 lb a.i./A) ¹	Oxadiazon Contact Dose (μg a.i./bee)	Acute RQ ²
Ornamentals, rights-of-way	Y (nectar & pollen)	4.0 lbs a.i./A	2.7	10.8	Not estimated

¹ Source: USEPA 2014. Guidance for Assessing Pesticide Risks to Bees

² Based on a 48-h acute contact LD₅₀ of >100 μg a.i./bee for oxadiazon (MRID 49984304).

Due to a non-definitive endpoint the available acute contact study to honey bee adults, the acute RQ for applications to ornamentals and rights-of-way was not estimated. However, if it were assumed that the highest dose tested was the acute endpoint, the contact dose would be approximately 0.1 the value of the contact toxicity endpoint.

10.3.2 Tier I Risk Estimation (Oral Exposure)

On-Field Risk

For oral exposure, the Tier I assessment considers just the caste of bees with the greatest oral exposure (foraging adults). If risks are identified, then other factors are considered for refining the Tier I risk estimates. These factors include other castes of bees and available information on residues in pollen and nectar which is deemed applicable to the crops of interest.

Given the non-definitive endpoint that was determined in the available acute oral study for honey bee adults, acute oral RQs for adult forager bees were not estimated. If the highest dose tested in that study (111 μg a.i./bee) was assumed to be the endpoint, it would approximately the level of the oral dose EEC (128 μg a.i./bee). The chronic LOC of 1.0 was exceeded for the registered use of oxadiazon for both adult and larval honey bees.

Table 10-3. Tier 1 (Default) Oral Risk Quotients for Adult Nectar Forager and Larval Worker Honey Bees

Use Pattern	Max. Single Appl. Rate	Bee Caste/Task	Unit Dose ($\mu\text{g a.i./bee}$ per 1 lb a.i./A) ¹	Oral Dose ($\mu\text{g a.i./bee}$)	Acute Oral RQ ^{2,3}	Chronic Oral RQ ⁴
Ornamentals, rights-of-way	4 lbs ai./A	Adult nectar forager	32	128	Not estimated	3.0
		Larval worker	13.6	54.4	Not estimated	10

¹ Source: USEPA 2014. Guidance for Assessing Pesticide Risks to Bees.

² Based on a 48-h acute oral LD₅₀ of >111 $\mu\text{g a.i./bee}$ for adults (MRID 49984304)

³ **Bolded** RQ value exceeds (or potentially exceeds) the acute risk LOC of 0.4 or chronic LOC of 1.0

⁴ Based on a 10-d chronic NOAEL of 43.4 $\mu\text{g a.i./bee/d}$ for adults (MRID 50580802) and a 22-d chronic NOAEL of 5.43 $\mu\text{g a.i./bee/d}$ for larvae (MRID 50580801)

Off-Field Risk

In addition to bees foraging on the treated field, bees may also be foraging in fields adjacent to the treated fields. Since chronic risk to larvae and adult honeybees are indicated on the treated field, risk off the treated field from spray drift are also expected. AgDRIFT (v2.1.1) modeling indicated that risk extends 10 -27 feet off field.

Table 10-4. Distance Risk Extends off Field for Adult and Larval Honeybees from Ground Applications of Oxadiazon to Ornamentals

Lifestage	Boom Length	App Rate lbs a.i./A (Fraction applied) ¹	Droplet Size	Distance (ft)
Larvae	Low	4 (0.33)	VF/F	4
			F/M-C	4
	High		VF/F	10
			F/M-C	4
	Low	4 (0.1)	VF/F	10
			F/M-C	4
	High		VF/F	27
			F/M-C	7

¹Fraction Applied = LOC/RQ. Chronic LOC = 1

10.3.3 Terrestrial Invertebrate Tier I Risk Assessment (Refined Oral Exposure)

There were no higher tier exposure or effects data available to refine the default Tier I results of the bee risk estimation for oxadiazon.

10.4 Terrestrial Invertebrate Risk Characterization – Additional Lines of Evidence

The default Tier I assessment determined a chronic risk concern for both adult and larval honey bees. Acute risk could not be estimated with precision due to the lack of definitive endpoints. There were no field residue trials in pollen or nectar or colony level effects studies to refine the results of Tier I nor were there additional Tier I studies on additional species of terrestrial invertebrates available to further characterize the risk of oxadiazon to this taxon. Additionally, there were no reported incidents concerning oxadiazon exposure and effects to terrestrial invertebrates.

Oxadiazon is registered on ornamentals, commercial turf (sod farms, golf course fairways), and rights-of-way. Given the likelihood of the managed practices of sod farms and golf course fairways to control for the presence of blooming weeds, on field exposure of bees and other pollinators is expected to be limited. However, exposure to the wide variety of ornamental species that are associated with blooms that could serve as pollinator attractive sites, as well as the presence of blooming weeds in rights-of-way areas, exposure to bees in these use areas cannot be precluded. There is currently no language on any of the oxadiazon labels for ornamentals and rights-of-way that would preclude its application during the bloom period of potentially attractive species. There are some labels that state to *“Avoid contact with flowers and shrubs except as recommended elsewhere on this label”* but does not restrict application to such; additionally, this language is not present on all labels.

According to the limited usage data available for oxadiazon, it is predominately applied to commercial and golf course turf relative to ornamentals. Additionally, when applying oxadiazon to either turf or ornamentals, current usage data indicates that it is applied as a granule, followed by watering in, for about 75% of the time. The application and subsequent watering in of a granule has a lower exposure potential to honey bee (but not necessarily other terrestrial invertebrates) relative to foliar applications. That is to say that the estimated on-field RQs for oxadiazon are primarily relevant for foliar applications to ornamentals and rights-of-way that represent approximately 25% of the total usage based on the currently available data.

10.5 Other Terrestrial Invertebrates

There are no other available data for other terrestrial invertebrates that were evaluated for oxadiazon.

11 Terrestrial Plant Risk Assessment

11.1 Terrestrial Plant Exposure Assessment

EECs for terrestrial plants are calculated using TERRPLANT v.1.2.2. Exposure is estimated for a single application evaluating exposure via spray drift and runoff. For spray drift, exposure is estimated approximately 200 feet from the edge of the treated field. For a dry area adjacent to the treatment area, runoff exposure is estimated as sheet runoff. Sheet runoff is the amount of pesticide in water that runs off of the soil surface of a target area of land that is equal in size to the non-target area (1:1 ratio of areas). For semi-aquatic areas, runoff exposure is estimated as channel runoff. Channel runoff is the amount of pesticide that runs off of a target area 10 times the size of the non-target area (10:1 ratio of areas). Exposures from runoff and spray drift are then compared to measures of survival and growth (e.g., effects to seedling emergence and vegetative vigor) to develop RQ values. Resulting upper-bound exposure estimates to terrestrial and semi-aquatic (wetland) plants adjacent to the treated field are in **Table 11-1**. EECs are based on the maximum single application rate for terrestrial uses, solubility, and spray drift fraction. The EECs represent residues from off-site exposure via spray drift and/or run-off to non-target plants found near application sites.

For oxadiazon, both flowable and granular applications are permitted. Therefore, ground spray applications of flowable were simulated and ground applications of granular. Notably, the model assumes no drift for ground applications of granular formulations.

Table 11-1. TerrPlant Calculated EECs for Terrestrial and Semi-Aquatic Plants near Oxadiazon Terrestrial Use Areas

Use Site	Single Max. Application Rate (lb a.i./A)	EECs (lb a.i./A) ¹		
		Ground ²		
		Dry Areas (Total)	Semi-Aquatic Areas (Total)	Spray Drift
Spray Applications				
Ornamentals (nursery), ornamentals (residential ground cover), turf, rights-of-way	4.0 lbs a.i./A	0.08	0.44	0.04
Granular Applications ⁴				
Ornamentals (nursery), ornamentals (residential ground cover), turf, rights-of-way	4.0 lbs a.i./A	0.04	0.4	0.0

¹ Based on a runoff fraction of 0.01 [solubility = 0.7 mg/L]

² Based on a drift fraction of 1% (*i.e.*, 0.01).

³ Based on a drift fraction of 5% (*i.e.*, 0.05).

⁴ Based on a drift fraction of 0%

11.2 Terrestrial Plant Risk Characterization

The most sensitive endpoints for monocots and dicot species of plants are based on dry weight in both the seedling emergence and vegetative vigor studies. For seedling emergence, monocot and dicot species were of similar sensitivity (EC₂₅ values ranging from 0.027 - 0.035 lbs a.i./A) whereas for vegetative vigor, the most sensitive dicot species was an order of magnitude more sensitive than the most sensitive monocot (EC₂₅ Of 0.049 and 0.37 lbs a.i./A, respectively).

Based on the available endpoints and the EECs calculated using TerrPlant (see above), risk above the LOC is indicated for non-listed plants for both monocot and dicot species from the registered uses of oxadiazon. The RQs for dicot were marginally higher than those from monocots from the same area of investigation. Ground applications (**monocots: 1.1 - 13; dicots: 1.5 - 16**) of the flowable formulations of oxadiazon. Due to the lower predicted exposure resulting from the absence of any drift fraction, RQs for granular applications were the lowest of all types of applications, with RQs below the LOC from spray drift contribution alone, and marginally above the LOC (**1.1 - 1.5**) for dry areas (see **Table 11-2**).

Table 11-2. Terrestrial Plant Risk Quotients (RQs) – Non-listed Species

Type of Plant	Ground Spray RQs		
	Dry Areas	Semi-Aquatic Areas	Spray Drift Only
Ornamentals (nursery), ornamentals (residential ground cover), turf, rights-of-way (flowable applications)			
Monocot	2.3	13	1.1
Dicot	3.0	16	1.5
Ornamentals (nursery), ornamentals (residential ground cover), turf, rights-of-way (granular applications)			
Monocot	1.1	11	<0.1
Dicot	1.5	15	<0.1

Bolded RQ values exceed the LOC of 1.0.

There are no major uncertainties that exist with the currently available dataset. Consistent with its registered uses as an herbicide, oxadiazon was associated with observed significant effects on plant dry weight, among other effects, in the available suite of terrestrial plant studies. While limited, this finding of risk above the LOC is further supported by a one reported plant incident in 2001, from oxadiazon's use on golf course turf. The incident report specified that approximately 30 acres of golf course fairways were observed to have severe turf burn in the overlap areas with other areas of the golf course.

12 Conclusions

Given the uses of oxadiazon and the chemical's environmental fate properties, there is a likelihood of exposure of oxadiazon to non-target terrestrial and aquatic organisms.

Risks of concern for this herbicide involve effects to aquatic species on a chronic basis, based on reductions in survival, reproduction and body length. Specifically, RQs for freshwater fish and estuarine/marine fish exceed the chronic LOC of 1.0 for all scenarios modeled to represent oxadiazon use on turf and ornamentals. Chronic RQs are also above the LOC for freshwater and estuarine/marine invertebrates for some scenarios modeled to represent turf and ornamentals. For benthic invertebrates, chronic RQs were above the LOC for both turf and ornamentals. As anticipated for an herbicide, risk is expected to both vascular and non-vascular plants for use of turf and ornamentals.

Chronic dose and dietary RQs are above the LOC for both birds and mammals (where applicable as chronic dose-based risk for birds not estimated); these exceedances extend across most feeding strategies with the exception of birds and mammals feeding on seeds. It is noted, that there were no effects observed in the available chronic 2-generation reproduction study up to and including the highest concentration tested; however, there is uncertainty as there is a significant gap in this highest tested level and the concentrations that are predicted in food items as a result of the application of oxadiazon, which is registered for use of up to 4 lbs a.i./A as a single application (8 lbs a.i./A, annually).

Due to bioaccumulation, there is also a concern for piscivorous birds and mammals; dose and dietary based chronic RQs are highest for mammals consuming contaminated fish. For terrestrial invertebrates, ornamentals are assumed to be attractive to honeybees; chronic adult oral RQs are above the LOC. As anticipated for a herbicide, risk is also expected for terrestrial plants.

A more in depth summary of the risk conclusions is available in the **Executive Summary**.

13 Literature Cited

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14 Referenced MRIDs

71-1 Avian Single Dose Oral Toxicity

MRID	Citation Reference
41610101	Pedersen, C. (1990) Oxadiazon Technical: 21-Day Acute Oral LD50 Study in Bobwhite Quail: Lab Project Number: BLAL/NO/89 QD 139. Unpublished study prepared by Bio-Life Associates, Ltd. 35 p.

71-2 Avian Dietary Toxicity

MRID	Citation Reference
41610102	Pedersen, C. (1990) Oxadiazon Technical: 8-Day Acute Dietary LC50 Study in Bobwhite Quail: Lab Project Number: BLAL/NO/89 QC 141. Unpublished study prepared by Bio-Life Associates, Ltd. 82 p.
41610103	Pedersen, C. (1990) Oxadiazon Technical: 8-Day Acute Dietary LC50 Study in Mallard Ducklings: Lab Project Number: BLAL/NO/89 DC 137. Unpublished study prepared by Bio-Life Associates, Ltd. 80 p.

71-4 Avian Reproduction

MRID	Citation Reference
41993201	Fletcher, D.; Pedersen, C. (1991) Oxadiazon Technical: Toxicity and Reproduction Study in Mallard Ducks: Lab Project Number: 89 DR 35. Unpublished study prepared by Bio-Life Associates, Ltd. 138 p.
41993202	Fletcher, D.; Pedersen, C. (1991) Oxadiazon Technical: Toxicity and Reproduction Study in Bobwhite Quail: Lab Project Number: 89 QR 39. Unpublished study prepared by Bio-Life Associates, Ltd. 145 p.

72-1 Acute Toxicity to Freshwater Fish

MRID	Citation Reference
42330401	Sword, M.; Northup, R. (1992) Acute Flow-Through Toxicity of Oxadiazon to Rainbow Trout (<i>Oncorhynchus mykiss</i>): Lab Project Number: 39729. Unpublished study prepared by ABC Laboratories, Inc. 211 p.
42350601	Sword, M.; Northup, R. (1992) Acute Flow-through Toxicity of Oxadiazon to Bluegill (<i>Lepomis macrochirus</i>): Final Report: Lab Project Number: 39728. Unpublished study prepared by ABC Labs., Inc. 194 p.

72-2 Acute Toxicity to Freshwater Invertebrates

MRID	Citation Reference
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42331801	Blasberg, J.; Bowman, J. (1992) Acute Toxicity of Oxadiazon to <i>Daphnia magna</i> under Flow-through Conditions: Amended Final Report: Lab Project Number: 39730. Unpublished study prepared by ABC Labs, Inc. 254 p.
72-3	Acute Toxicity to Estuarine/Marine Organisms
MRID	Citation Reference
42615801	Machado, M. (1992) Oxadiazon Technical--Acute Toxicity to Sheepshead Minnow (<i>Cyprinodon variegatus</i>) under Flow-through Conditions: Final Report: Lab Project Number: 92-8-4383 10566.0392.6237.505. Unpublished study prepared by Springborn Labs, Inc. 66 p.
42615802	Machado, M. (1992) Oxadiazon Technical--Acute Toxicity to Mysid Shrimp (<i>Mysidopsis bahia</i>) under Flow-through Conditions: Final Report: Lab Project Number: 92-7-4348: 10566.0392.6236.515. Unpublished study prepared by Springborn Labs, Inc. 65 p.
72-4	Fish Early Life Stage/Aquatic Invertebrate Life Cycle Study
MRID	Citation Reference
42921601	Rhodes, J. (1993) Early Life-Stage Toxicity of Oxadiazon Technical to the Fathead Minnow (<i>Pimephales promelas</i>) Under Flow-Through Conditions: Lab Project Number: 40024. Unpublished study prepared by ABC Labs. Inc., Environmental Toxicology. 432 p.
48759101	York, D. (2012) Oxadiazon: Early Life-Stage Toxicity Test with Fathead Minnow (<i>Pimephales promelas</i>) Under High Light Conditions: Final Report. Project Number: 13971/6106, TK0001570. Unpublished study prepared by Smithers Viscient Laboratories. 78p.
81-1	Acute oral toxicity in rats
MRID	Citation Reference
105140	Mayhew, D.; Kingery, A. (1982) Acute Oral Toxicity Study in Albino Rats with Oxadiazon: WIL-81268. (Unpublished study received Jun 21, 1982 under 359-707; prepared by WIL Research Laboratories, Inc., submitted by Rhone-Poulenc, Inc., Monmouth Junction, NJ; CDL:247728-A)
119075	Mayhew, D.; Valerio, J.; Kingery, A. (1982) Acute Oral Toxicity Study in Albino Rats with Oxadiazon/Fertilizer (the Andersons-- Ohio): WIL-81258. (Unpublished study received Dec 8, 1982 under 359-707; prepared by WIL Research Laboratories, Inc., submitted by Rhone-Poulenc, Inc., Monmouth Junction, NJ; CDL:248967-A)

41866501	Rush, R. (1990) Acute Oral Toxicity Study in Rats with Oxadiazon: Final Report: Lab Project Number: 3147.84. Unpublished study prepared by Springborn Laboratories, Inc. 26 p.
42775201	Cerven, D. (1992) Single Dose Oral Toxicity in Rats/LD50 in Rats: Regal O-O Herbicide: Lab Project Number: MB 92-1656 A. Unpublished study prepared by MB Research Labs, Inc. 11 p.
43570901	Cerven, D. (1994) Single Dose Oral Toxicity/LD50 in Rats: Regal Star II: Lab Project Number: 94/3618/A. Unpublished study prepared by MB Research Labs, Inc. 10 p.
44883401	Moore, G. (1999) Acute Oral Toxicity Study in Rats--Limit Test: ANDRD101: Lab Project Number: 7424: P320. Unpublished study prepared by Product Safety Labs. 14 p. {OPPTS 870.1100}

123-1 Seed germination/seedling emergence and vegetative vigor

MRID	Citation Reference
46676502	Christ, M.; Lam, C. (2005) Tier II Seedling Emergence: Nontarget Phytotoxicity Study Using Ronstar WP50. Project Number: 201246, EBOAX011. Unpublished study prepared by Bayer CropScience LP. 57 p.
46676503	Christ, M.; Nuessle, C. (2005) Tier II Vegetative Vigor: Nontarget Phytotoxicity Study Using Ronstar WP50. Project Number: 201247, EBOAX013. Unpublished study prepared by Bayer CropScience LP. 69 p.

123-2 Aquatic plant growth

MRID	Citation Reference
41610105	Giddings, J. (1990) Oxadiazon Technical-Toxicity to the Marine Diatom Skeletonema costatum: Lab Project Number: 90-7-3384; 10566-1089-6137-450. Unpublished study prepared by Springborn Laboratories, Inc. 55 p.
41610106	Giddings, J. (1990) Oxadiazinon Technical-Toxicity to the Fresh-water Diatom Navicula pelliculosa: Lab Project Number: 90-8-3423; 10566-1089-6137-440. Unpublished study prepared by Springborn Laboratories, Inc. 52 p.
41610107	Giddings, J. (1990) Oxadiazon Technical-Toxicity to the Duckweed Lemna gibba G3: Final Report: Lab Project Number: 90-7-3389; 10566.1089.6137.410. Unpublished study prepared by Springborn Laboratories, Inc. 48 p.

141-1 Honey bee acute contact

MRID	Citation Reference

42468301 Beevers, M. (1992) Acute Contact Toxicity of Oxadiazon Technical to Honey Bees (Apis mellifera L.): Lab Project Number: CAR 160-92. Unpublished study prepared by California Agricultural Research, Inc. 14 p.

161-1 Hydrolysis

MRID	Citation Reference
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41863603	Corgier, M.; Robin, J. (1991) Oxadiazon ?Carbon 14 Hydrolysis at 25 Degrees Centigrade: Lab Project Number: 91-02. Unpublished study prepared by Rhone-Poulenc, Secteur Agro. 56 p.
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161-3 Photodegradation-soil

MRID	Citation Reference
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41898201	Das, Y. (1989) Photodegradation of ?Phenyl(U)?carbon 14 Oxidiazon on Soil Under Artificial Sunlight: Lab Project Number: 89110. Unpublished study prepared by Innovative Scientific Services, Inc. 119 p.
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163-1 Leach/adsorp/desorption

MRID	Citation Reference
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41889501	Priestley, D.; Lowden, P.; Savage, E. (1991) Oxadiazon-[carbon 14]: Leaching Study with Four Soils: Lab Project Number: P91/051. Unpublished study prepared by Rhone-Poulenc Agric., Ltd. 48 p.
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830.7570 Partition coefficient (n-octanol/water), estimation by liquid chromatography

MRID	Citation Reference
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48821510	Eyrich, U.; Ziemer, F. (2011) Oxadiazon (AE F082671), Technical Substance: Partition Coefficient 1-Octanol / Water (HPLC Method). Project Number: M/419390/01/2/OCR, PA11/106. Unpublished study prepared by Bayer CropScience AG. 20p.
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830.7840 Water solubility: Column elution method, shake flask method

MRID	Citation Reference
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48821505	Wiche, A.; Ziemer, F. (2011) Oxadiazon (AE F082671), Technical Substance: Solubility in Distilled Water and at pH 5 and pH 9 (Column Elution Method). Project Number: M/419376/01/2/OCR, PA11/107. Unpublished study prepared by Bayer CropScience AG. 37p.
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830.7950 Vapor pressure

MRID	Citation Reference
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46747501	Mitchell, H. (2006) Product Chemistry of Ronstar G Herbicide. Project Number: 201464, ANR/01806, ANR/02006. Unpublished study prepared by Bayer Corp. 146 p.
850.1400	Fish early-life stage toxicity test
MRID	Citation Reference
48759101	York, D. (2012) Oxadiazon: Early Life-Stage Toxicity Test with Fathead Minnow (<i>Pimephales promelas</i>) Under High Light Conditions: Final Report. Project Number: 13971/6106, TK0001570. Unpublished study prepared by Smithers Viscient Laboratories. 78p.
870.1100	Acute oral toxicity
MRID	Citation Reference
46183404	Moore, G. (2003) Acute Oral Toxicity Up and Down Procedure in Rats: S9944 (ProTurf Goosegrass/Crabgrass). Project Number: 13508, P320/UDP. Unpublished study prepared by Product Safety Labs, Food Products Laboratory, and Silliker Laboratories of New Jersey, Inc. 16 p.
46593601	Kuhn, J. (2005) Acute Oral Toxicity Study (UDP) in Rats: Magic Carpet Fertilizer with 1.00% Ronstar: Final Report. Project Number: 8979/05. Unpublished study prepared by Stillmeadow, Inc. 10 p.
46597103	Durando, J. (2005) AND5043: Acute Oral Toxicity Up and Down Procedure in Rats. Project Number: 17242, P320/UDP, 050328/1R. Unpublished study prepared by Product Safety Laboratories. 14 p.
46763306	Kuhn, J. (2005) Acute Oral Toxicity Study (UDP) in Rats: Ronstar 0.95% Plus Fertilizer: Final Report. Project Number: 9031/05. Unpublished study prepared by Stillmeadow, Inc. 12 p.
46964101	Lowe, C. (2006) Acute Oral Toxicity Up and Down Procedure in Rats: Harell's Fertilizer with Starteem #3. Project Number: 19890, P320/UDP. Unpublished study prepared by Product Safety Laboratories. 14 p.
47511702	Hutcheson, S. (2008) Bridging Statement Concerning Applicability Existing of Acute Toxicity Studies to Starfighter L. Project Number: PEC/066T. Unpublished study prepared by Rivendell Consulting USA, LLC. 6 p.
47817901	Durando, J. (2009) PrePair Ornamental Herbicide: Acute Oral Toxicity Up and Down Procedure in Rats. Project Number: 27125, P320/UDP. Unpublished study prepared by Eurofins/Product Safety Laboratories. 15 p.

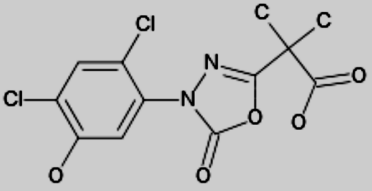
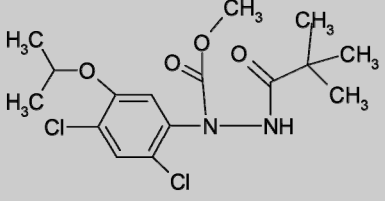
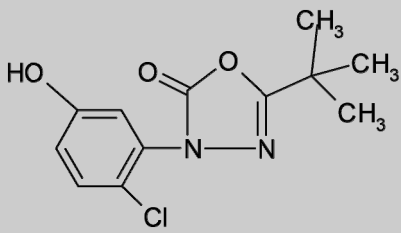
Appendix A. Oxadiazon Transformation Products and Un-extracted Residues

1. Environmental Transformation Products

Oxadiazon transformation products structures and other available information are summarized in **Table A-1**.

Table A-1. Oxadiazon Transformation Products Observed in Various Laboratory Studies

Common Names		Other Information	Structure
RP 17272	AE 0618784, Methoxy Oxadiazon	Molecular Weight: 317.1679 Empirical Formula: C ₁₃ H ₁₄ Cl ₂ N ₂ O ₃ CAS Number: 19666-31-0 CAS Name: 3-(2,4-Dichloro-5-methoxyphenyl)-5-(1,1-dimethylethyl)-1,3,4-oxadiazol-2(3H)-one SMILES: <chem>COC1CC(N2N=C(OC2=O)C(C)(C)C)C(Cl)CC1Cl</chem>	
RP 25496	AE 0608021, Phenolic Oxadiazon	Molecular Weight: 303.1413 Empirical Formula: C ₁₂ H ₁₂ Cl ₂ N ₂ O ₃ CAS Number: 39807-19-7 CAS Name: 3-(2,4-Dichloro-5-hydroxyphenyl)-5-(1,1-dimethylethyl)-1,3,4-oxadiazol-2(3H)-one SMILES: <chem>CC(C)(C)C1NN(C(=O)O1)C2C(C(Cl)Cl)C(O)C2</chem>	
RP 26123	AE 0608022, Oxadiazon Hydrazide	Molecular Weight: 319.2268 Empirical Formula: C ₁₄ H ₂₀ Cl ₂ N ₂ O ₂ CAS Number: 51167-18-1 CAS Name: 2-[2,4-Dichloro-5-(1-methylethoxy)phenyl]hydrazide 2,2-dimethylpropanoic acid	
RP 26449	AE 0616182, Oxadiazon Acid	Molecular Weight: 375.2039 Empirical Formula: C ₁₅ H ₁₆ Cl ₂ N ₂ O ₅ CAS Numbers: 57198-84-2 CAS Name: 4-[2,4-Dichloro-5-(1-methylethoxy)phenyl]-4,5-dihydro-α,α-dimethyl-5-oxo-1,3,4-oxadiazole-2-acetic acid	

Common Names		Other Information	Structure
RP 26471	AE 0618795, t-Butyl carboxy Desisopropyl Oxadiazon	Molecular Weight: 333.1242 Empirical Formula: C ₁₂ H ₁₀ Cl ₂ N ₂ O ₅ CAS Number: 54996-62-2 CAS Name: 4-(2,4-Dichloro-5-hydroxyphenyl)-4,5-dihydro- α,α -dimethyl-5-oxo-1,3,4-oxadiazole-2-acetic acid	
RP 32507	AE 0607884	Molecular Weight: 377.3 g/mol Empirical Formula: C ₁₆ H ₂₂ Cl ₂ N ₂ O ₄ CAS Numbers: 56578-26-8 CAS Name: Hydrazinecarboxylic acid, l-[2,4-dichloro-5-(1-methylethoxy)phenyl]-2-(2,2-dimethyl-1-oxopropyl)-, methyl ester SMILES: COC(=O)N(NC(=O)C(C)(C)C)c1cc(OC(C)C)c(Cl)cc1Cl	
RP36939			
RP37084			
RPA 409407	AE 1151405	Molecular Weight: 268.7 g/mol Empirical Formula: C ₁₂ H ₁₃ ClN ₂ O ₃ CAS Numbers: CAS Name: 1,3,4-Oxadiazol-2(3H)-one, 3-(2-chloro-5-hydroxyphenyl)-5-(1,1-dimethylethyl) SMILES: CC(C)(C)C1=NN(C(=O)O1)c2cc(O)ccc2Cl	

Half-lives and degradation details observed in laboratory-based environmental fate studies are included in **Table A-2**.

Table A-2 Oxadiazon Degradation Details for Laboratory-based Environmental Fate Studies

Study	Half-lives ¹ , System and Degradation Details	MRID (Classification) ²
Hydrolysis (31 d Study; 25 °C)	Stable @ pHs 4, 5 & 7; $t_{1/2}$ = 38 d @ pH 9 Major Degradates at pH 9 only: RP26123 Max 41% @EOS CO₂ (not determined)	418636-03 (A)
Aqueous Photolysis (42 hours Study; 25 °C)	2.75 d (FL summer sunlight) (SFO) @ pH 5 Major Degradate: RP37084 Max 12% Minor Degradate: RP36939 Max 5% Unidentified degradates: Up to 20 mostly <8% CO₂: Max 7%	418972-01 (A)
Soil Photolysis (30 d Study; 25 °C)	165 d on a CA sandy loam soil (pH 7.5; Organic Carbon= O.C= 0.1%) Major Degradate: None Minor Degradate: RP25496 and RP17272 Max <5% each CO₂: Max 3%	418982-01 (A)
Aerobic Soil	866 d (SFO-Ln) on a CA sandy loam soil (pH 7.8; O.C= 1%)	427728-01 (S)

Study	Half-lives ¹ , System and Degradation Details	MRID (Classification) ²
(365 d study; 25 °C)	Major Degradate: None Minor Degradate: RP17272 and RP26471 Max 1.5% each @ 120 and 178 d; RP26496, RP26449, and RP26123 Max 1.5% each @ 120 Unidentified degradates: Four degradates ≤1% each UER: Max 5% CO₂: Max 7%	
Aerobic Soil (365 d Study= End of study= EOS= 365 d; 20 °C)	1,246 d (SFO) on a UK Clay loam soil (pH 6.7, O.C 2%) 1,055 d (SFO) on a UK Sandy loam soil (pH 4.7, O.C 1.3%) 756 d (SFO) on a UK Sandy loam soil (pH 6.2, O.C 3.3%) Major Degradate: None Minor Degradate: RP17272 Max 1-4% @ 300-EOS, RP25496 Max 0.1-4% @ 300-EOS and RPA409407 Max 0.2-2.3% @ 181-EOS; RP32507 Max 0.2 @ 300 d Unidentified degradates: <1-3% UER: Max 10-16% CO₂: Max 1-3%	501307-01 (S)
Aerobic Aquatic (101 d study; 20 °C)	241 d (SFO) on a marine water: sand sediment from Rodeo beach, CA: marine water. Sediment (pH 8.5 at collection then ranged from 7.9 to 8 during study period, O.C= 0.1%) and marine water (pH 7.7 at collection then ranged from 8.1 to 8.2 during study period); Major & Minor Degradate: None Unidentified degradates: Three degradates Max 0.4- 5% UER: Max 5% CO₂: Max 2.5%	494052-01 (S)
Aerobic Aquatic³ (97 d study; 20 °C)	460 d (SFO) on a UK Sandy loam lake sediment: water. Sediment (pH 7.3, O.C= 4%) and water (pH 6.4, O.C= 5 mg/L) 617 d (SFO) on a UK Sandy clay loam sediment: water. Sediment (pH 8.1, O.C= 2.7%) and water (pH 7.0, O.C= 19 mg/L) Major Degradate: None Minor Degradate: RP25496 Max 0.5 and 0.3% , respectively UER: Max 31 and 27% (one sample 46%), respectively CO₂: Max 1.9% and 1.4%, respectively	465947-01 (S)
Anaerobic Aquatic⁴ (366 d study; 25 °C)	571 d (SFO) for 0-366 day data and 893 d (SFO) for 0-269 day data System: CA sandy loam soil (pH 7.5; Organic Carbon= O.C= 0.1%) Major Degradate: None Minor Degradate: RP25496 Max 1.5% @ 120 d, RP26471 Max 1.5% @ 120 d, RP26449 Max 0.4% @ 181 d, RP26123 Max 3.8% @ 269 d, and RP36227 Max 0.5% @ 269 d UER: Max 3% CO₂: Max <1%	427738-02 (S)

¹ **Half-lives:** SFO=single first order; **SFO-LN**=SFO calculated using natural log transformed data; DFOP=double first order in parallel; DFOP slow DT₅₀=slow rate half-life of the DFOP fit

² **Studies classification:** A= Acceptable, S= Supplemental; N/A= Not applicable noting that Studies submitted since the Problem Formulation was completed are designated with an ^N in association with the MRID number

³ **Anaerobic Aquatic Half-lives** recalculated after omitting replicates containing more than 5% un-extracted residues (UER) from 7 to 28 day and by applying a correction for >42-day data to include the level of 8% UER (refer to unextracted residue data, below) in this Appendix for more details concerning the high unextracted residues found in this study

⁴ **Anaerobic Aquatic:** This study was performed on a soil rather than sediment. DER was modified by considering data for one of the replicates (180-day sample) as an outlier. For this replicate, a cluster of radioactivity (18% of the applied) was not characterized. Additionally, two half-lives were calculated one

Study	Half-lives ¹ , System and Degradation Details	MRID (Classification) ²
-------	--	------------------------------------

for all data while the other for data up to 269 days by considering data for the 366-day sample as an outlier, Half-life was recalculated using NAFTA PEST DF. In the problem formulation (PF) indicated that the chemical is to be considered stable in anaerobic aquatic systems

2. Un-extracted Residues (UER)

Extraction systems, efficiency and the level of unextracted residue (UER) observed in various fate studies are summarized in **Table A-3**.

Table A-3. Extraction Systems/Efficiency Used in Various Fate Studies

Study (MRID;(Length; and Incubation Temperature)	Extracted Sample Interval(s)	Extraction Systems	Maximum Level of UER ¹
Aerobic Soil (501307-01); 365 d Study)	0-300 d	System 1: Acetone followed by HCl acidified methanol	1 st soil: 10%;
	365 d	System 1 followed by Soxhlet extraction with Acetonitrile: Water and Dichloromethane: Water	2 nd soil: 15%; 3 rd soil: 35%
Aerobic Soil (427728-01; 365 d study; 25 °C)	All	System 1: Acetone followed by HCl acidified methanol	5%
Aerobic Aquatic (494052-01; 101 d study) ²	All	System 2: Soxhlet extraction with Acetonitrile: Water followed by Methanol acidified by Formic Acid	5%
Aerobic Aquatic (465947-01; 97 d study; 20 °C) ³	42 d	System 3: Methylene Chloride followed by Acetone	1 st system: 17-45%
	Others	System 4: HCL acidified Acetone	2 nd system: 12-35%
Anaerobic Aquatic (427738-02; 366 d study; 25 °C)	All	System 1: Acetone followed by HCl acidified methanol	3%

¹ **Level of UER**= Level of unextracted residue

² Samples were microwaved as a last step to assist extraction

³ Sample flasks were washed by a sonification bath

Based on submitted fate studies and extraction data presented in **Table A-3**, extraction systems and resultant levels of UER were as follows:

- (1) Acceptable levels (<10%) by using extraction **system 1** for in aerobic soil and two anaerobic aquatic systems and by using **system 2** in one aerobic aquatic system; and
- (2) Unacceptable high levels (>10%) by using extraction **system 1** in two aerobic soils and by using **systems 3 or 4** in two aerobic aquatic systems.

It appears that extractions with acetone pulled the majority of the chemical Oxadiazon. Less than 8% of the applied radioactivity was observed after exhaustive extractions; noting that this additional extracted radioactivity consisted of oxadiazon (Figure A-1). Based on this data, it was assumed that exhaustive extraction would yield an additional 8% of oxadiazon and samples containing more than the acceptable levels of UER were corrected accordingly. For example, if a sample contains 79% oxadiazon and 30% UER it is assumed that further extraction would release 8% of oxadiazon parent. In this case the data point used for this sample, in calculating oxadiazon half-life, is corrected to be 87% oxadiazon (79%+8%= 87%) and the 22% UER (30%-

8%) is considered to bound residue. This correction was applied to samples containing high amounts of UER in two aerobic aquatic systems

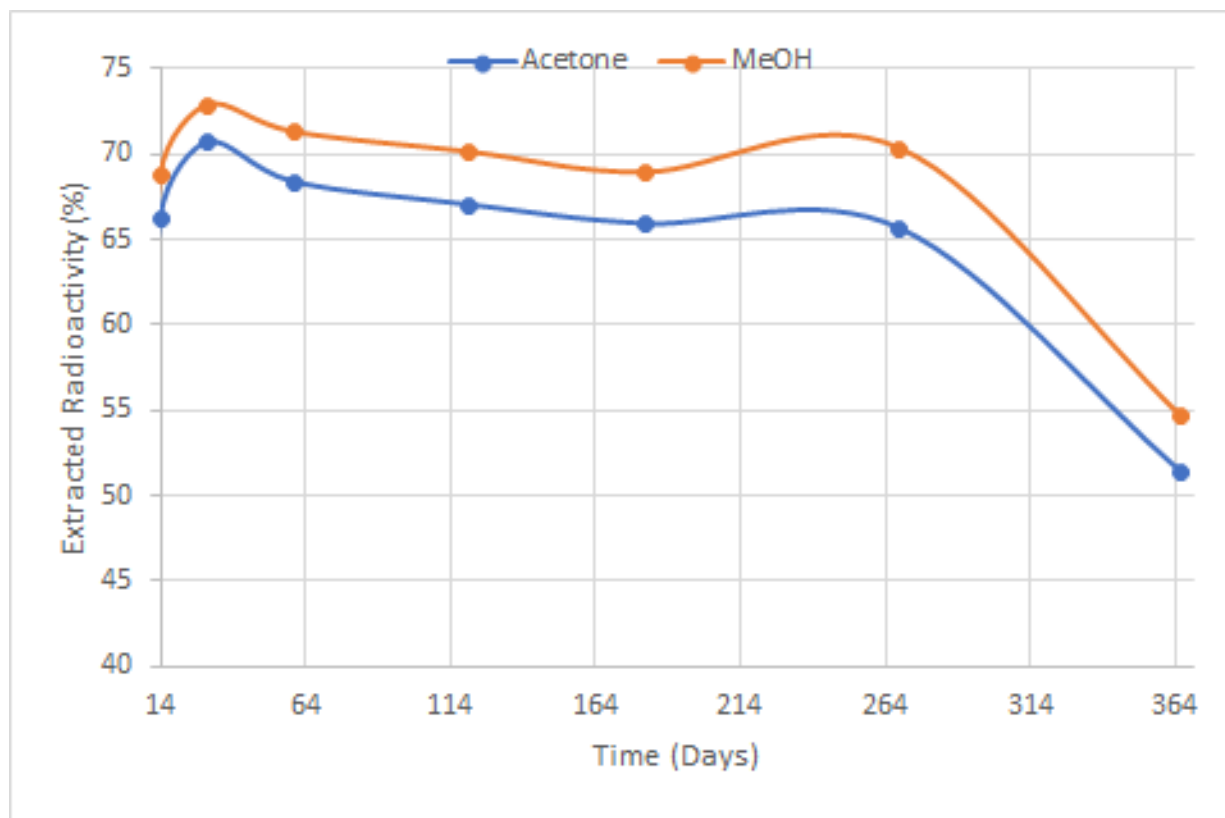


Figure A-1. Oxadiazon extracted by acetone alone and that extracted with additional HCl acidified methanol extraction step (anaerobic aquatic system; MRID 427738-02)

Appendix B. Example Aquatic Modeling Output and Input Batch Files

NJ Nurseries: Scenario: NJnurserySTD_V2

Estimated Environmental Concentrations for Oxadiazon are presented in **Table B-1** for the USEPA standard pond with the NJnurserySTD_V2 field scenario. A graphical presentation of the year-to-year peaks is presented in **Figure B-1**. These values were generated with the Pesticide Water Calculator (PWC), Version 1.52. Critical input values for the model are summarized in **Tables B-2** and **B-3**.

This model estimates that about 2% of Oxadiazon applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (61% of the total transport), followed by spray drift (31%) and erosion (7%).

In the water body, pesticide dissipates with an effective water column half-life of 194.1 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main sources of dissipation in the water column are photolysis (effective average half-life = 301 days) followed by volatilization (1,031.4 days) and metabolism (1,158.7 days).

In the benthic region, pesticide is stable. Most of the pesticide in the benthic region (99.61%) is sorbed to sediment rather than in the pore water.

Table B-1. Estimated Environmental Concentrations (ppb) for Oxadiazon.

Peak (1-in-10 yr)*	106
4-day Avg (1-in-10 yr)	104
21-day Avg (1-in-10 yr)	84.2
60-day Avg (1-in-10 yr)	76.1
365-day Avg (1-in-10 yr)	70.2
Entire Simulation Mean	58.5

* 111 ppb for 1-day

Table B-2. Summary of Model Inputs for Oxadiazon.

Scenario	NJnurserySTD_V2
Cropped Area Fraction	1
Koc (ml/g)	3,268
Water Half-Life (days) @ 25 °C	551
Benthic Half-Life (days) @ 25 °C	0.0
Photolysis Half-Life (days) @ 40 °Lat	2.75
Hydrolysis Half-Life (days)	0.0
Soil Half-Life (days) @ 25 °C	888

Foliar Half-Life (days)	
Molecular Weight	345.20
Vapor Pressure (torr)	7.76e-7
Solubility (mg/l)	0.7
Henry's Constant	2.06E-05

Table B-3. Application Schedule for Oxadiazon.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
03/22	Ground	4.484	0.99	0.062
07/22	Ground	4.484	0.99	0.062

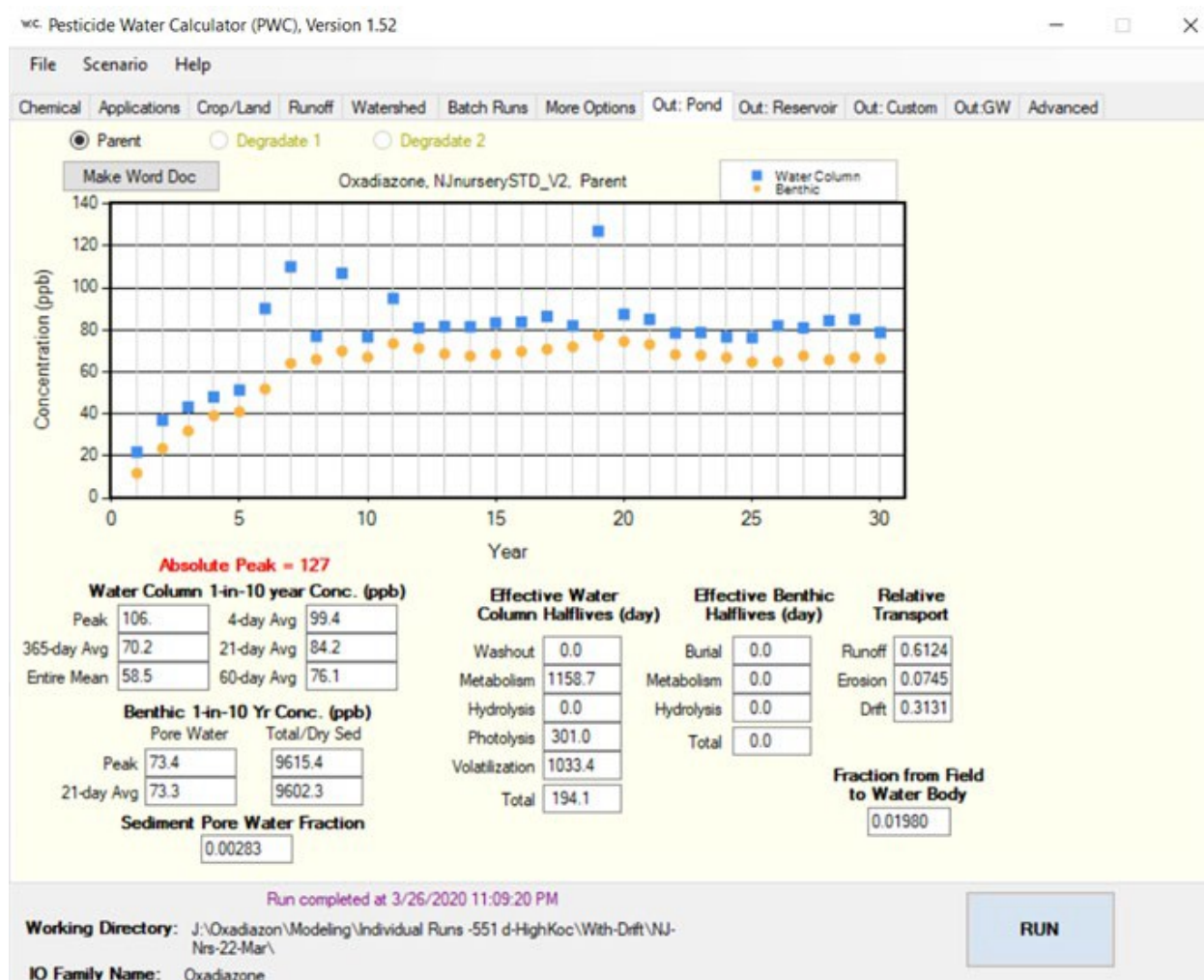


Figure B-1. Yearly Peak Concentrations

Appendix C. Example Output for Terrestrial Modeling

T-REX

Upper Bound Kenaga Residues For RQ Calculation

Chemical Name:	Oxadiazon
Use	0
Formulation	0
Application Rate	4 lbs a.i./acre
Half-life	35 days
Application Interval	120 days
Maximum # Apps./Year	2
Length of Simulation	1 year
Variable application rates?	no

Acute and Chronic RQs are based on the Upper Bound Kenaga Residues.

The maximum single day residue estimation is used for both the acute and reproduction RQs.

RQs reported as "0.00" in the RQ tables below should be noted as <0.01 in your assessment. This is due to rounding and significant figure issues in Excel.

Endpoints			
Avian	Bobwhite quail	LD50 (mg/kg-bw)	2150.00
	Bobwhite quail	LC50 (mg/kg-diet)	5000.00
	Bobwhite quail	NOAEL(mg/kg-bw)	0.00
	Bobwhite quail	NOAEC (mg/kg-diet)	500.00
Mammals		LD50 (mg/kg-bw)	5000.00
		LC50 (mg/kg-diet)	5000.00
		NOAEL (mg/kg-bw)	15.50
		NOAEC (mg/kg-diet)	200.00
Dietary-based EECs (ppm)		Kenaga Values	
Short Grass		1049.16	
Tall Grass		480.86	
Broadleaf plants		590.15	
Fruits/pods/seeds		65.57	
Arthropods		410.92	

Avian Results

	Avian	Body	Ingestion (Fdry)	Ingestion (Fwet)	% body wgt	FI
	Class	Weight (g)	(g bw/day)	(g/day)	consumed	(kg-diet/day)
	Small	20	5	23	114	2.28E-02
	Mid	100	13	65	65	6.49E-02
	Large	1000	58	291	29	2.91E-01
	Granivores	20	5	5	25	5.06E-03
		100	13	14	14	1.44E-02
		1000	58	65	6	6.46E-02
	Avian Body Weight (g)	Adjusted LD50 (mg/kg-bw)				
20	1548.92					
100	1971.86					
1000	2785.32					
Dose-based EECs (mg/kg-bw)	Avian Classes and Body Weights (grams)					
	small 20	mid 100	large 1000			
Short Grass	1194.89	681.38	305.06			
Tall Grass	547.66	312.30	139.82			
Broadleaf plants	672.12	383.27	171.60			
Fruits/pods	74.68	42.59	19.07			
Arthropods	468.00	266.87	119.48			
Seeds	16.60	9.46	4.24			
Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)					
	20	100	1000			
Short Grass	0.77	0.35	0.11			
Tall Grass	0.35	0.16	0.05			
Broadleaf plants	0.43	0.19	0.06			
Fruits/pods	0.05	0.02	0.01			
Arthropods	0.30	0.14	0.04			
Seeds	0.01	0.00	0.00			
Dietary-based RQs (Dietary-based EEC/LC50 or NOAEC)	RQs					
	Acute	Chronic				
Short Grass	0.21	2.10				
Tall Grass	0.10	0.96				
Broadleaf plants	0.12	1.18				
Fruits/pods/seeds	0.01	0.13				
Arthropods	0.08	0.82				

Mammalian Results

Mammalian Class	Body Weight	Ingestion (Fdry) (g bwt/day)	Ingestion (Fwet) (g/day)	% body wgt consumed	FI (kg-diet/day)
Herbivores/ insectivores	15	3	14	95	1.43E-02
	35	5	23	66	2.31E-02
	1000	31	153	15	1.53E-01
Grainvores	15	3	3	21	3.18E-03
	35	5	5	15	5.13E-03
	1000	31	34	3	3.40E-02

Mammalian Class	Body Weight	Adjusted LD50	Adjusted NOAEL
Herbivores/ insectivores	15	10989.15	34.07
	35	8891.40	27.56
	1000	3845.80	11.92
Granivores	15	10989.15	34.07
	35	8891.40	27.56
	1000	3845.80	11.92

Dose-Based EECs (mg/kg-bw)	Mammalian Classes and Body weight (grams)		
	15	35	1000
Short Grass	1000.29	691.34	160.29
Tall Grass	458.47	316.86	73.47
Broadleaf plants	562.67	388.88	90.16
Fruits/pods	62.52	43.21	10.02
Arthropods	391.78	270.77	62.78
Seeds	13.89	9.60	2.23

Dose-based RQs (Dose-based EEC/LD50 or NOAEL)	Small mammal 15 grams		Medium mammal 35 grams		Large mammal 1000 grams	
	Acute	Chronic	Acute	Chronic	Acute	Chronic
Short Grass	0.09	29.36	0.08	25.08	0.04	13.44
Tall Grass	0.04	13.46	0.04	11.50	0.02	6.16
Broadleaf plants	0.05	16.52	0.04	14.11	0.02	7.56
Fruits/pods	0.01	1.84	0.00	1.57	0.00	0.84
Arthropods	0.04	11.50	0.03	9.82	0.02	5.27
Seeds	0.00	0.41	0.00	0.35	0.00	0.19

Dietary-based RQs (Dietary-based EEC/LC50 or NOAEC)	Mammal RQs	
	Acute	Chronic
Short Grass	0.21	5.25
Tall Grass	0.10	2.40
Broadleaf plants	0.12	2.95
Fruits/pods/seeds	0.01	0.33
Arthropods	0.08	2.05

Appendix D. Example Output for Terrestrial Plant Modeling

TerrPlant v. 1.2.2

Green values signify user inputs (Tables 1, 2 and 4).

Input and output guidance is in popups indicated by red arrows.

Table 1. Chemical Identity.				
Chemical Name	Oxadiazon			
PC code	109001			
Use	Turf, ornamentals			
Application Method	Aerial			
Application Form	Spray			
Solubility in Water (ppm)	0.7			
Table 2. Input parameters used to derive EECs.				
Input Parameter	Symbol	Value	Units	
Application Rate	A	4	y	
Incorporation	I	1	none	
Runoff Fraction	R	0.01	none	
Drift Fraction	D	0	none	
Table 3. EECs for Oxadiazon. Units in y.				
Description	Equation		EEC	
Runoff to dry areas	(A/I)*R		0.04	
Runoff to semi-aquatic areas	(A/I)*R*10		0.4	
Spray drift	A*D		0	
Total for dry areas	((A/I)*R)+(A*D)		0.04	
Total for semi-aquatic areas	((A/I)*R*10)+(A*D)		0.4	
Table 4. Plant survival and growth data used for RQ derivation. Units are in y.				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	0.035	x	0.37	x
Dicot	0.027	x	0.05	x
Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Oxadiazon through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	1.14	11.43	<0.1
Monocot	listed	#VALUE!	#VALUE!	#VALUE!
Dicot	non-listed	1.48	14.81	<0.1
Dicot	listed	#VALUE!	#VALUE!	#VALUE!
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Appendix E. Example Output for Terrestrial Invertebrate Modeling

BEE-REX

Table 1. User inputs (related to exposure)

Description	Value
Application rate	4
Units of app rate	lb a.i./A
Application method	foliar spray
Are empirical residue data available?	no

Table 5. Results (highest RQs)

Exposure	Adults	Larvae
Acute contact	0.108	NA
Acute dietary	1.17	#DIV/0!
Chronic dietary	2.96	10.02

Table 2. Toxicity data

Description	Value (µg a.i./bee)
Adult contact LD50	100
Adult oral LD50	110
Adult oral NOAEL	43.4
Larval LD50	
Larval NOAEL	5.43

Table 3. Estimated concentrations in pollen and nectar

Application method	EECs (mg a.i./kg)	EECs (µg a.i./mg)
foliar spray	440	0.44
soil application	NA	NA
seed treatment	NA	NA
tree trunk	NA	NA

Appendix F. Example Output for Terrestrial Bioaccumulation Model

Table 11. Estimated concentrations of Oxadiazon in ecosystem components.

Ecosystem Component	Total concentration (µg/kg-ww)	Lipid normalized concentration (µg/kg-lipid)	Contribution due to diet (µg/kg-ww)	Contribution due to respiration (µg/kg-ww)
Water (total)*	95	N/A	N/A	N/A
Water (freely dissolved)*	95	N/A	N/A	N/A
Sediment (pore water)*	77	N/A	N/A	N/A
Sediment (in solid)**	7,278	N/A	N/A	N/A
Phytoplankton	354,257	17712875	N/A	354,257.50
Zooplankton	270,725	9024164	6,902.30	263,822.61
Benthic Invertebrates	300,345	10011505	17,521.99	282,823.15
Filter Feeders	197,293	9864640	11,287.20	186,005.61
Small Fish	432,765	10819132	75,961.80	356,803.48
Medium Fish	497,371	12434266	150,325.36	347,045.26
Large Fish	647,593	16189822	310,772.04	336,820.85

* Units: µg/L; **Units: µg/kg-dw

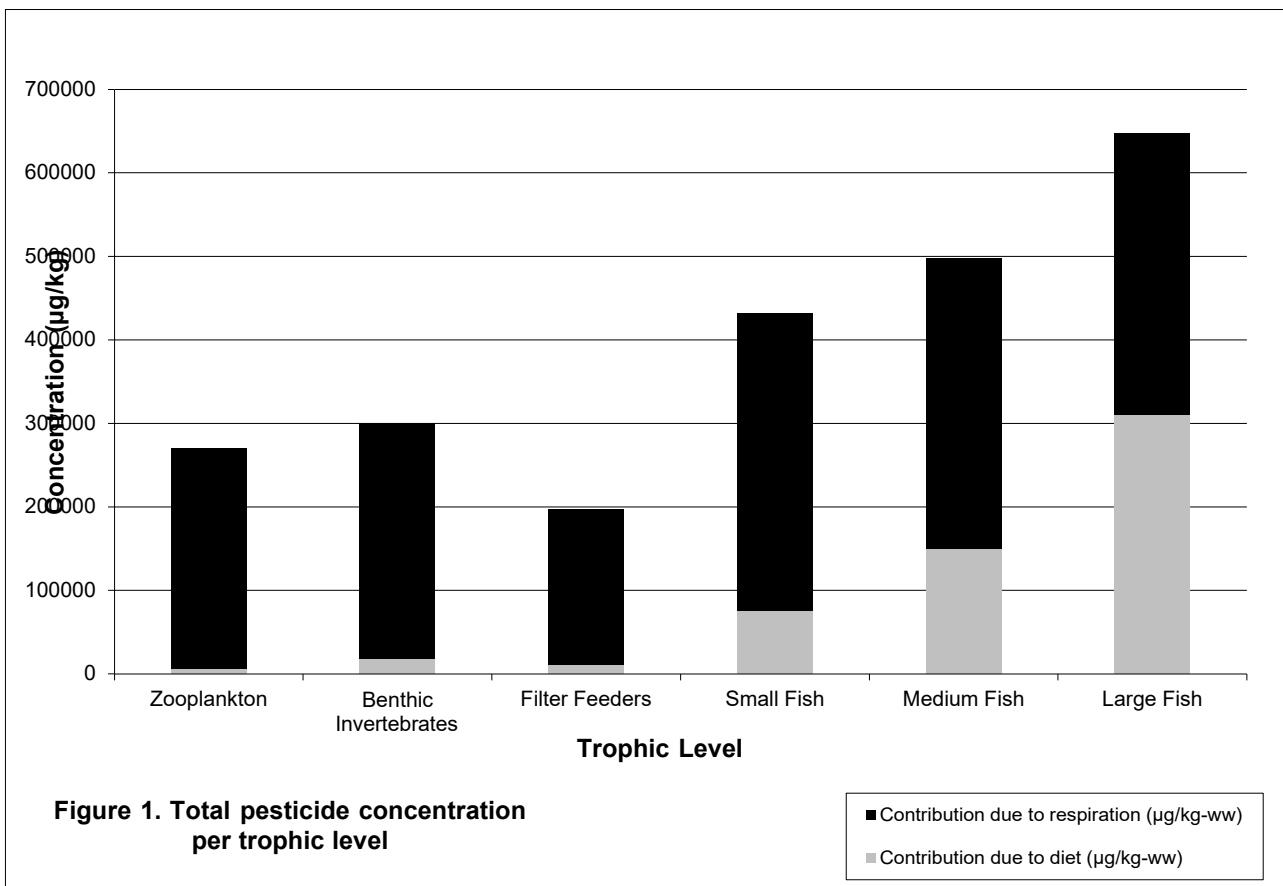


Table 12. Total BCF and BAF values of Oxadiazon in aquatic trophic levels.

Trophic Level	Total BCF ($\mu\text{g/kg-ww}/(\mu\text{g/L})$)	Total BAF ($\mu\text{g/kg-ww}/(\mu\text{g/L})$)
Phytoplankton	3902	3717
Zooplankton	2781	2841
Benthic Invertebrates	3008	3152
Filter Feeders	1977	2070
Small Fish	3869	4541
Medium Fish	3869	5219
Large Fish	3906	6795

Table 13. Lipid-normalized BCF, BAF, BMF and BSAF values of Oxadiazon in aquatic trophic levels.

Trophic Level	BCF ($\mu\text{g/kg-lipid}/(\mu\text{g/L})$)	BAF ($\mu\text{g/kg-lipid}/(\mu\text{g/L})$)	BMF ($\mu\text{g/kg-lipid}/(\mu\text{g/kg-lipid})$)	BSAF ($\mu\text{g/kg-lipid}/(\mu\text{g/kg-OC})$)
Phytoplankton	195124	185864	N/A	97
Zooplankton	92691	94692	0.51	50
Benthic Invertebrates	100261	105053	1.13	55
Filter Feeders	98870	103511	1.12	54
Small Fish	96732	113527	1.14	59
Medium Fish	96732	130475	1.19	68
Large Fish	97660	169883	1.30	89

Table 14. Calculation of EECs for mammals and birds consuming fish contaminated by Oxadiazon.

Wildlife Species	Biological Parameters				EECs (pesticide intake)	
	Body Weight (kg)	Dry Food Ingestion Rate (kg-dry food/kg-bw/day)	Wet Food Ingestion Rate (kg-wet food/kg-bw/day)	Drinking Water Intake (L/d)	Dose Based (mg/kg-bw/d)	Dietary Based (ppm)
Mammalian						
fog/water shrew	0.02	0.140	0.585	0.003	175.777	300.35
rice rat/star-nosed mole	0.1	0.107	0.484	0.011	150.021	310.04

small mink	0.5	0.079	0.293	0.048	145.892	497.37
large mink	1.8	0.062	0.229	0.168	113.990	497.37
small river otter	5.0	0.052	0.191	0.421	95.037	497.37
large river otter	15.0	0.042	0.157	1.133	101.761	647.59
Avian						
sandpipers	0.0	0.228	1.034	0.004	321.9188	311.36
cranes	6.7	0.030	0.136	0.211	45.3015	333.33
rails	0.1	0.147	0.577	0.010	211.6463	366.56
herons	2.9	0.040	0.157	0.120	62.7844	398.86
small osprey	1.3	0.054	0.199	0.069	99.1838	497.37
white pelican	7.5	0.029	0.107	0.228	69.1008	647.59

Table 15. Calculation of toxicity values for mammals and birds consuming fish contaminated by Oxadiazon.

Wildlife Species	Toxicity Values			
	Acute		Chronic	
	Dose Based (mg/kg-bw)	Dietary Based (mg/kg-diet)	Dose Based (mg/kg-bw)	Dietary Based (mg/kg-diet)
Mammalian				
fog/water shrew	10499.51	N/A	32.55	310
rice rat/star-nosed mole	7122.50	N/A	22.08	310
small mink	4695.52	N/A	14.56	310
large mink	3320.24	N/A	10.29	310
small river otter	2571.84	N/A	7.97	310
large river otter	1954.18	N/A	6.06	310
Avian				
sandpipers	1548.92	5000.00	N/A	500

cranes	3704.99	5000.00	N/A	500
rails	1869.13	5000.00	N/A	500
herons	3267.65	5000.00	N/A	500
small osprey	2880.13	5000.00	N/A	500
white pelican	3768.21	5000.00	N/A	500

Table 16. Calculation of RQ values for mammals and birds consuming fish contaminated by Oxadiazon.

Wildlife Species	Acute		Chronic	
	Dose Based	Dietary Based	Dose Based	Dietary Based
Mammalian				
fog/water shrew	0.017	N/A	5.400	0.969
rice rat/star-nosed mole	0.021	N/A	6.794	1.000
small mink	0.031	N/A	10.023	1.604
large mink	0.034	N/A	11.075	1.604
small river otter	0.037	N/A	11.920	1.604
large river otter	0.052	N/A	16.798	2.089
Avian				
sandpipers	0.208	0.062	N/A	0.623
cranes	0.012	0.067	N/A	0.667
rails	0.113	0.073	N/A	0.733
herons	0.019	0.080	N/A	0.798
small osprey	0.034	0.099	N/A	0.995
white pelican	0.018	0.130	N/A	1.295

Appendix G. Endocrine Disruptor Screening Program (EDSP)

As required by FIFRA and the Federal Food, Drug, and Cosmetic Act (FFDCA), EPA reviews numerous studies to assess potential adverse outcomes from exposure to chemicals. Collectively, these studies include acute, subchronic and chronic toxicity, including assessments of carcinogenicity, neurotoxicity, developmental, reproductive, and general or systemic toxicity. These studies include endpoints which may be susceptible to endocrine influence, including effects on endocrine target organ histopathology, organ weights, estrus cyclicity, sexual maturation, fertility, pregnancy rates, reproductive loss, and sex ratios in offspring. For ecological hazard assessments, EPA evaluates acute tests and chronic studies that assess growth, developmental and reproductive effects in different taxonomic groups. As part of the Draft Ecological Risk Assessment for Registration Review, EPA reviewed these data and selected the most sensitive endpoints for relevant risk assessment scenarios from the existing hazard database. However, as required by FFDCA section 408(p), oxadiazon is subject to the endocrine screening part of the Endocrine Disruptor Screening Program (EDSP).

EPA has developed the EDSP to determine whether certain substances (including pesticide active and other ingredients) may have an effect in humans or wildlife similar to an effect produced by a “naturally occurring estrogen, or other such endocrine effects as the Administrator may designate.” The EDSP employs a two-tiered approach to making the statutorily required determinations. Tier 1 consists of a battery of 11 screening assays to identify the potential of a chemical substance to interact with the estrogen, androgen, or thyroid (E, A, or T) hormonal systems. Chemicals that go through Tier 1 screening and are found to have the potential to interact with E, A, or T hormonal systems will proceed to the next stage of the EDSP where EPA will determine which, if any, of the Tier 2 tests are necessary based on the available data. Tier 2 testing is designed to identify any adverse endocrine-related effects caused by the substance, and establish a dose-response relationship between the dose and the E, A, or T effect.

Under FFDCA section 408(p), the Agency must screen all pesticide chemicals. Between October 2009 and February 2010, EPA issued test orders/data call-ins for the first group of 67 chemicals, which contains 58 pesticide active ingredients and 9 inert ingredients. A second list of chemicals identified for EDSP screening was published on June 14, 2013^[1] and includes some pesticides scheduled for registration review and chemicals found in water. Neither of these lists should be construed as a list of known or likely endocrine disruptors. Oxadiazon is not on List 1. For further information on the status of the EDSP, the policies and procedures, the lists of chemicals, future lists, the test guidelines and Tier 1 screening battery, please visit our website^[2]

^[1] See <http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPPT-2009-0477-0074> for the final second list of chemicals.

^[2] Available: <http://www.epa.gov/endo/>